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Healthcare Leadership

Maximizing The Impact of Nursing Care Quality:

A Closer Look at the Hospital Work Environment and the Nurse's Impact on Patient-Care Quality

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EXECUTIVE SUMMARY

Nurses are the cornerstone of hospital care delivery and the hospital's most costly and valuable resource; their efficiency and effectiveness are central to any effort to maximize patient safety or minimize costs. Studies suggest that elements of the current hospital work environment, including inefficient work processes and physical designs, gaps in technology infrastructure, and unsupportive organizational cultures, contribute to inefficiencies and stress for hospital nurses, limiting the time they can spend in direct patient care. These same elements contribute to nurse burnout, which, in turn, hinders the recruitment and retention of nurses. Furthermore, reduced nurse-patient ratios have been linked to increased mortality, highlighting the fact that nurse staffing and efficiency are linchpins of patient safety. Innovations in hospital design and work processes have the potential to enhance the recruitment and retention of staff, increase the efficiency of care delivery, and improve the quality of clinical care and patient safety while avoiding reimbursement penalties.

This article reviews the evidence relating to nursing work processes and their inseparability from physical space, infrastructure, and patient safety and highlights potential solutions to promote transformational change to the nursing work environment.

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INTRODUCTION

The United States hospital system balances on a point of transition. Tremendous challenges, including growing work-force shortages, ever-tightening fiscal demands, and the perennial imperative of patient safety, pressure hospital caregivers and administrators alike. Furthermore, the Centers for Medicaid and Medicare Services (CMS) are moving forward with policies to limit payment for hospital-acquired conditions and complications (Centers for Medicare and Medicaid Services, 2008).

Concurrently, an unparalleled wave of hospital construction and renovation presents a unique opportunity to affect hospital care delivery for a generation. In 2007, $45 billion was poured into healthcare construction, an expenditure expected to reach $67.2 billion by 2012 and representing one of the largest hospital building booms in history (FMI, 2008). These challenges and opportunities form an imperative for hospital chief executive officers (CEOs) to evaluate evidence-based approaches to improving the efficiency, safety, and cost of care delivery. *(For more on the forces shaping the healthcare environment, see "The Business Case for Building Better Hospitals Through Evidence-Based Design" by Blair L. Sadler, Jennifer R. DuBose, Eileen B. Malone, and Craig M. Zimring.)*

Nurses are the cornerstone of hospital care delivery and the hospital's most costly and valuable resource; their efficiency and effectiveness are central to any effort to maximize patient safety or minimize costs. Studies suggest that elements of the current hospital work environment, including inefficient work processes and physical designs, gaps in technology infrastructure, and unsupportive organizational cultures, contribute to inefficiencies and stress for hospital nurses, limiting the time they can spend in direct patient care (Hendrich, Chow, Skierczynski, & Lu, 2008). These same elements contribute to nurse burnout, which, in turn, hinders the recruitment and retention of nurses. Furthermore, reduced nurse-patient ratios have been linked to increased mortality, highlighting the fact that nurse staffing and efficiency are linchpins of patient safety (Aiken, Clarke, Sloane, Sochalski, & Silber, 2002).

Bold changes to the hospital work environment are essential. Innovations in hospital design and work processes have the potential to enhance the recruitment and retention of staff, increase the efficiency of care delivery, and improve the quality of clinical care and patient safety while avoiding reimbursement penalties. The seminal Institute of Medicine (IOM) report, "Keeping Patients Safe: Transforming the Work Environment of Nurses," identified four major sources of threats to patient safety: work force, management, work processes, and organizational culture (Institute of Medicine, 2004). *(For more on cultural change and facility design, see "Culture Change and Facility Design: A Model for Joint Optimization" by D. Kirk Hamilton, Robin Diane Orr, and W. Ellen Raboin.)*

Two nursing organizations (American Organization of Nurse Executives, 2004; American Association of Critical-Care Nurses, 2005) have also issued standards for healthy nursing work environments (Table 1). These standards highlight the importance of collaboration, communication, accountability, and recognition of the role of nursing. Recent research has identified four specific categories of inefficiency in

nursing practice that represent opportunities for bold action. These categories are the processes and technologies of documentation, medication administration, communication, and supplies and equipment management (Hendrich et al., 2008; Tucker & Spear, 2006; Gurses & Carayon, 2007).

Achieving transformational change in each of these categories will require the integration of new technologies, work processes, and architectural designs, and the collaboration of key stakeholders across the hospital system. The CEO must both demonstrate and demand the collaboration of all partners—vendors, physicians, nurses, support staff, and others—in the transformation of the hospital work environment. The modern CEO must be able to see the playing field that includes all systems—information technology (IT), pharmacy, supply chain—and how they integrate and perform within the work environment to support the caregiver, patient, and organization. The success of the CEO's leadership will be measured in the organization's ability to deliver value and safety to the patient, with high levels of clinical effectiveness, and satisfaction for patient and caregiver alike. *(For more on the role of the CEO, see "Implementing Healthcare Excellence: The Vital Role of the CEO in Evidence-Based Design" by Craig Zimring, Godfried L. Augenbroe, Eileen B. Malone, and Blair L. Sadler.)*

This article reviews the evidence relating to nursing work processes and their inseparability from physical space, infrastructure, and patient safety and highlights potential solutions to promote transformational change to the nursing work environment. The findings are summarized as a list of questions that CEOs may wish to ask themselves to guide their assessment of, and lead change to, the hospital work environment (Table 2). These questions emphasize collaboration between caregivers and departments, seamless integration of different IT systems (i.e., interoperability), cooperation of vendors, the involvement of key stakeholders (physicians, nurses, patients) in management and planning, and the use of an evidence-based approach to achieving transformational change. The importance of the issues contained in these questions, and their relevance to nursing care quality, is examined in the body of this paper. *(For more on cultural change and facility design, see Hamilton, Orr, and Raboin.)*

NURSING AND PATIENT OUTCOMES

Strong evidence links nurse staffing and the quality of the nurse work environment to the efficiency of nursing care and patient outcomes (Clarke & Aiken, 2006). Nurse staffing has been the subject of extensive research. Efforts by a dozen states to mandate nurse staffing levels speak to the mounting evidence that characteristics of the nursing work force affect patient care (American Nurses Association, 2007). In their large 2002 study, Aiken et al. demonstrated a 7% increase in mortality (and a 7% increase in the odds of failure to rescue) for every additional patient per staff nurse (Aiken et al., 2002).

The work of investigators around the world supports these findings. Studies from North America, Europe, Russia, and New Zealand have demonstrated a link between nurse staffing, the quality of the nurse working environment, and quality of patient care (Clarke & Aiken, 2006). A recent study from England, for example, reported that surgical patients in hospitals in the lowest quartile of patient-to-nurse ratio had consistently better outcomes (Rafferty et al., 2007). Hospitals with the highest patient-to-nurse ratios had 26% higher mortality, and nurses in these hospitals were approximately twice as likely to be dissatisfied with their jobs, show high burnout levels, and report low or deteriorating quality of care.

As intuitive as this finding appears to be (i.e., more nursing equals better care), the mechanisms affecting the relationship between nurse staffing and preventable patient mortality are multiple and not thoroughly understood. Nursing skill mix, relationship and communication with clinicians, organizational status, stress, and job satisfaction are among

the factors suggested to influence patient outcomes (Aiken, Sloane, & Sochalski, 1998). At least some of these issues can be affected by the work environment.

A GROWING PROBLEM:
THE NURSING WORK-FORCE SHORTAGE

Evidence of the impact of nurse staffing on patient outcomes suggest that one approach to maximizing outcomes and minimizing errors is to hire more nurses. The well-documented nursing work-force shortage, unfortunately, complicates any attempt to increase nurse-patient ratios. Despite some recent gains, the current nursing work-force shortage is expected to grow substantially over coming decades. Estimates of the projected gap between supply and demand for RNs range from 340,000 to more than 1 million nurses by 2020 (Anderson, 2007).

Among the forces contributing to increased demand and limited supply are demographic factors and insufficient capacity of health professional schools. The population of the United States is growing and growing older. By 2025, the population is projected to increase by 12%; by 2045, the proportion of people over 65 years of age is estimated to peak at approximately 20% (U.S. Census Bureau, 2000). The growth and aging of the population increase demand for healthcare resources, while simultaneously reducing the supply of young people who are available for employment. The work-force shortage is exacerbated by limited growth in nursing education programs, which reached a nadir in 2001 (O'Neil, 2007).

The limited supply of nurses in the work force emphasizes the importance of attracting and retaining nurses. Several nurse-related factors that may influence patient outcomes, such as organizational status, relationship and communication with clinicians, and stress may also influence nurses' job satisfaction and burnout, in turn, affecting retention and, ultimately, nurse staffing and patient outcomes (Aiken et al., 1998). This loop describes a set of characteristics that may help to differentiate higher performing healthcare organizations. Creating a desirable work environment that incorporates the recommendations from the American Organization for Nurse Executives and the American Association of Critical-Care Nurses

(see Table 1) and other key features should be a main theme of organizational change.

RETAINING THE HOSPITAL'S MOST
VALUABLE RESOURCE

Creating a desirable, efficient, healing environment is critical for retaining nurses and maximizing safety and minimizing cost. In a study of working nurses, 41% said they were dissatisfied with their jobs, and 22% were planning on leaving their jobs within the next year (Aiken et al., 2001). With the cost of RN turnover estimated to be $62,100 to $67,100 per nurse, the financial incentive for staff retention is clear (Jones, 2005). Higher rates of turnover are associated with higher costs per discharge and lower profitability compared to lower turnover rates (Kosel & Olivo, 2002; Jones, 2008).

Furthermore, many of the pay-for-performance indicators are clearly in the hands of nurses as either the primary source of prevention and/or the individual responsible for organizing and coordinating the care team. Examples include pressure ulcers, falls, and urinary tract infections (Kovner & Gergen, 1998). Hospitals that suffer from a high voluntary nurse turnover and minimal nurse time available for patient care will face steep odds in avoiding poor patient experiences and managing the CMS reimbursement changes. As others have suggested, it may be time to ask the question: Does a national nursing shortage truly exist, or is there actually a shortage of nurses who desire to work in the current hospital environment?

THE INTERFACE BETWEEN NURSING AND THE
WORK ENVIRONMENT

A clear relationship has been demonstrated between RN hours spent on direct patient care and decreased

risk of hospital-related death and shorter length of stay (Anderson, 2007). Emerging evidence, however, suggests that nurses' time is not efficiently used, and that nurses spend only a minority of time on patient assessment, vital signs, and surveillance (Hendrich et al., 2008). The strongest evidence to date was provided through "A Multisite Study: How Medical-Surgical Nurses Spend Their Time" (Time and Motion Study) funded in part by grants from the Robert Wood Johnson Foundation and the Gordon and Betty Moore Foundation (Hendrich et al., 2008).

In this study, investigators employed radio frequency identification (RFID) positioning technology to examine the movements of 767 medical-surgical nurses at 36 diverse hospital settings (see Appendix for list of study sites). Nurses were asked to concurrently record their work activities at random times throughout their shift on a programmed personal digital assistant, allowing for a determination of how much time nurses spent on various activities. Nurses also wore an armband that validated steps taken, speed of travel, and calories burned per minute while on shift and off shift. Each nursing unit was studied for seven consecutive days resulting in work patterns from more than 2,000 shifts and approximately 22,000 hours of nursing activities.

While approximately three-quarters of nurses' time was devoted to nursing practice activities, only 7.2% of this time was spent on patient contact that was considered physical assessment and surveillance. An additional 19.3% of nursing practice time was dedicated to patient-care activities. In contrast, the majority of nursing practice time was accounted for by three other activity categories: documentation (35.3%), medication administration (17.2%), and care coordination (20.6%). The category of care coordination consisted mainly of communication with the care team and other departments.

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Together, these three activities consumed more than half of a typical 10-hour nursing shift (average of 306 out of 600 minutes). Nurses also traveled long distances. During 10-hour daytime shifts, nurses walked a median of 3.0 miles. Comparatively, off-shift nurses traveled a median of 2.1 miles in the daytime, nearly a full mile less. Thus, hospital nurses are walking considerably more while at work on a nursing unit than while off work (Hendrich et al., 2008). Previous studies have identified walking as a major time consumer for nurses; other investigators have found that time saved walking translates into more time spent on patient-care activities (Hendrich, 2003; Trites, Galbraith, Sturdavant, & Leckwart, 1970).

Analysis of a subset of units in the Time and Motion Study found that nurses on units with a single, centralized nurse and medication station made fewer entries to the medication station than nurses on units with more than one such station (unpublished data).

Nurses on units with a centralized medication station also made fewer trips to assigned patient rooms. It may be that nurses on units with a centralized medication station combine multiple tasks into fewer trips. Although this analysis is based on a small sample size, the findings suggest that unit layout can affect nurses' strategies for obtaining medications and that these strategies may affect the number of trips made to assigned patient rooms. It is conceivable that the locations of other necessary materials, such as equipment and supplies, also affect nurses' behavior and are important considerations in unit design and organization.

In the Time and Motion Study, the variation in miles traveled and time spent with patients was greater between nurses on the same unit than across units (Hendrich et al., 2008). In other words, the study was unable to demonstrate differences between unit layouts (radial, racetrack, corridor) in terms of time

spent with patients or distance traveled. It appears that nurses' ability to adapt to different layouts and patient assignments veiled any effect of unit architecture. This finding suggests that the nurses' individual ability to organize their work and staffing assignments may represent a substantial opportunity for improving efficiency. Nurses with geographically contiguous patient assignments, for example, traveled less than nurses with patient assignments based on acuity of illness who were in noncontiguous rooms, regardless of unit layout (Hendrich et al., 2008). Ongoing analyses of Time and Motion Study data will attempt to delineate the effects of patient assignments, unit layout, and other factors on nurses' time and distance traveled.

WORK ENVIRONMENT: STRESS, SAFETY, AND PATIENT OUTCOMES

A key finding of the Time and Motion Study was a demonstration of the physical and workload demands on hospital nurses. Nurses traveled long distances on average and also spent a large proportion of time on activities such as documentation, medication administration, and care coordination (communication with care team) (Hendrich et al., 2008). Although documentation is a valued and necessary patient-related activity, the volume and duplication of documentation often results in loss of precious nursing time and increased workload. The nursing shortage exacerbates workload demands. Studies of nurse workload have reported that nurses often work longer than scheduled—in one study, approximately 40% of 5,317 work shifts exceeded 12 hours (Rogers, Hwang, Scott, Aiken, & Dinges, 2004)—and must cope with frequent system failures and interruptions.

Disruptions in the supply of materials or information, also called work-system failures, contribute to nursing workload and stress. Tucker and Spear reported that nurses experience an average of 8.4 work system failures per 8-hour shift (Tucker & Spear, 2006). The five most common work system failures reported by nurses involved disruptions in the supply of medications, orders, supplies, staffing, and equipment. Average time per task per 8-hour shift was only 3.1 minutes; nevertheless, nurses were interrupted midtask an average of 8 times per shift. System failures related to supplies and equipment have been noted by other investigators

as well and are a common source of wasted nursing time. One cross-sectional study of the work environment of intensive-care nurses found that nurses frequently reported searching for supplies (24% of nurses) and misplaced (20%) or unavailable equipment (32%) as major performance obstacles (Gurses & Carayon, 2007).

Implications of high workload include nurse stress, safety, job dissatisfaction, burnout, and effects on patient safety and satisfaction with care. In Aiken's 2002 study, for example, each additional patient per nurse was associated with a 23% increase in the odds of burnout and a 15% increase in the odds of job dissatisfaction (Aiken et al., 2002). Increased nurse workloads also increase the risk for errors. Authors have demonstrated a significant increase in the risk for errors when work shifts exceed 12 hours or when nurses work overtime or more than 40 hours per week (Rogers et al., 2004).

Nurse workload and stress can be exacerbated by low staffing and poor organizational support. Nurse reports of low-quality care are three times as likely in hospitals with low staffing and support compared to those with high staffing and support (Aiken et al., 2002). In a large cross-sectional analysis of 20 urban hospitals across the United States, patients in units that nurses characterized as having adequate staff, good administrative support, and good relations between doctors and nurses were more than twice as likely to report high satisfaction with care (Vahey, Aiken, Sloane, Clarke, & Vargas, 2004). Nurses also reported significantly lower burnout, and the overall level of nurse burnout was associated with patient satisfaction.

Strong organizational support and leadership, therefore, can contribute to a work environment that nurses find desirable and safe, limits staff stress and burnout, promotes the efficient delivery of care, and maximizes patient safety and outcomes. This conclusion is supported by studies of hospitals with strong organizational support for nurses. At such magnet hospitals, nurses report high levels of autonomy, control over practice, and collaboration with physicians; these hospitals are known for attracting nurses (Aiken et al., 1998). One study comparing 39 magnet hospitals to 195 control (nonmagnet) hospitals found that observed mortality in magnet hospitals was 7.7% lower compared to matched control hospitals (p = 0.011), and adjusted mortality was 4.6% lower (p = 0.026) (Aiken, Smith, & Lake, 1994). Analysis of variables suggested that the difference in mortality was not due to differences in nurse staffing, but rather to organizational attributes (Aiken et al., 1998).

EVIDENCED-BASED DESIGN AND THE WORK ENVIRONMENT

A body of literature has evolved in recent years describing the impact of the built environment on staff and patients alike. Elements of the physical environment that affect staff and patients include the presence of stressors, such as excessive noise; features that limit the risk for errors, such as adequate lighting, areas for uninterrupted work, and acuity-adaptable rooms; floor layouts that reduce walking and increase time spent on direct patient care; and features that reduce the risk for nosocomial infections. Both staff morale and patient satisfaction can be improved through integrated environmental design features such as incorporating patient and family spaces to support family participation in the care process; the design of attractive, pleasant environments; and the use of smaller units with good visual access between staff and patients (Joseph, 2006c).

Other features of hospital design affect the efficiency and accuracy of care delivery and bridge the gap between physical structure and organization. These features include the information and communications infrastructure, systems of medication administration, and novel approaches to the provision of supplies and equipment.

Several excellent reviews of evidence-based hospital design have been published in recent years (Ulrich et al., 2008; Joseph, 2006a; Joseph, 2006b; Joseph, 2006c; Joseph & Ulrich, 2007). The most comprehensive of these reviews is the report by Ulrich and colleagues; a summary of their recommendations is presented in Table 3 (Ulrich et al., 2008). In all of these reports, aspects of the built environment contributed to patient safety and satisfaction, staff stress and fatigue, and overall healthcare quality. *(For an in-depth review of the available research, see "A Review of the Research Literature on Evidence-Based Healthcare Design" by Roger S. Ulrich, Craig Zimring, Xuemei Zhu, Jennifer DuBose, Hyun-Bo Seo, Young-Seon Choi, Xiaobo Quan, and Anjali Joseph.)*

WHAT SMART CEOS WILL DO: HOLISTIC INTEGRATION OF WORK ENVIRONMENT KNOWLEDGE

The complex interplay of these related elements—hospital work environment, sufficiency of nursing care, work processes, technology infrastructure, and features of hospital design—shape patient experience and outcomes, and the efficiency and stress levels of nurses and other healthcare workers (Figure 1). The mutual dependency of these elements indicates the need for a holistic, integrated approach to the design of hospitals that can foster positive, healing environments for patients and staff alike. Time and again, the literature demonstrates that adequate supply and efficient use of nursing time on direct patient-care activities improves patient outcomes and fosters job satisfaction among staff. Factors that influence this equation include the ratio of RNs to patients, organizational support for nursing staff, elements of the physical environment, and specific work processes that foster teamwork and collaboration.

When the results of the Time and Motion Study are triangulated with the existing evidence described

above, a new vista emerges as an imperative for hospital and organizational transformation. Focusing on the work process areas that consume more than half of available nursing time sanctions the executive team with powerful evidence to target and eliminate wasted professional time. Various solutions should be matched against each category, with the intent of improving organizational performance while shifting professional nursing time back to direct, or value added, care processes that impact care quality and safety. Review of the literature suggests four work-process categories for targeted improvement: (1) documentation, (2) medication administration, (3) communication (care coordination), and (4) supplies and equipment management.

Each is briefly described here with corresponding challenges and improvements. Table 4 details specific changes for each category—both incremental and transformational—and their implications for the physical environment. Examples of transformational change highlight integration across departments and systems, the interoperability of technologies, automation of processes, and decentralization where appropriate. The incremental change suggestions are items that any hospital can easily act upon that will modestly improve nursing efficiency and increase time available for direct patient care. The transformational change suggestions may require greater effort and/or capital investment to implement, but have the potential to dramatically increase the amount of time that nurses have for direct patient care. Some of the change suggestions will require accommodations in the physical environment, and these have been highlighted in the last column. With this range of suggestions in each of the four categories, all hospitals should be able to find something they can implement to improve nursing efficiency.

1. Documentation

As demonstrated by the Time and Motion Study, documentation is one of the most time-consuming nursing activities (Hendrich et al., 2008). For some time, many healthcare professionals have believed that the introduction of the electronic health record (EHR) would reduce the documentation time required by all caregivers. However, the EHR may actually increase time required by the caregiver in the early stages of implementation—and

perhaps longer—if careful attention is not paid to the design and build phase of various views, forms, and charts. The temptation to add additional data collection fields in the EHR can be difficult to overcome, and, as a result, many systems have had to refine their electronic assessment forms and graphic displays of patient data based upon caregiver experience and workflow. Another challenge arises from the multiple log-in requirements until system integration is complete. Redesigning work-flow processes *prior* to the creation and implementation of the EHR can help to overcome some of these challenges. Nevertheless, it is essential to have an ongoing assessment process to evaluate how much time nurses actually spend on documentation, even after implementation, so that work-flow changes can be made.

The phasing of the integrated EHR and migration away from the paper record will continue for the foreseeable future. Having a raised awareness of the critical nature of EHR design can help to reduce the risk of adding unintended documentation time for caregivers. As regulatory and public policy demand for specific documentation requirements are introduced (such as present on admission), healthcare systems will need robust processes driven by caregivers to avoid adding time to documentation (Centers for Medicare and Medicaid Services, 2006).

The location of terminals and/or wireless devices and the type of surface or device used to support data entry remain controversial and highly varied. Wireless carts on wheels can be found in many medical surgical units sitting idle in the hallways while nurses still carry handwritten information to centralized locations. Other systems have experienced high nursing

satisfaction with the cart as a mobile device that goes with the nurse to concurrently document and record patient status. This range in perceptions underscores the fact that the adoption of any new work process requires the direct involvement of care providers and a keen awareness of how the physical space and work flow support or detract from the intended goal to document concurrently. Attention to the complex interplay of these elements is essential to successfully implementing new work processes.

The lack of interoperability between data collection devices and the EHR means that nurses and other care providers often act as a human interfaces between data collection systems. The manual transfer of electronically captured data from any device to the EHR consumes nursing time and contributes to transcription errors. Even the hospital bed has become a source of patient data elements (turning, exiting, weighing, call light, actuated voice communication) that do not interface with the EHR. The nurse must collect and enter these data elements when device interfaces could eliminate redundancy, save nursing time, and improve data accuracy.

On the horizon, direct involvement of patients in their health records holds great potential for accuracy, caregiver interaction with the patient and family, and a reduction of time required by the nurse to enter patient information. The greatest opportunity for improvement may be the duplication and redundancy between departments and between disciplines. Few care delivery models have a single patient-problem list that all care providers use to plan, coordinate, and intervene with the patient. The result is fragmentation of care, duplication of data sets, and the inability to quantify the outcome (quality and cost) of the care provided. This lack of integration and a common patient-problem list creates a need for manual checklists that act to validate care processes between disciplines and care team members on behalf of the patient.

2. Medication Administration

Medication administration may be one of the categories most affected by the fragmentation of informatics infrastructure and interoperability. One solution for reducing fragmentation and its negative effect on nurse efficiency is to implement a closed-loop medication system. A closed-loop medication system assures that computerized physician order entry,

positive patient identification, order verification, unit-dose dispensing with bar coding, and caregiver identification cannot be disrupted. Nurses spend inordinate amounts of time on various parts of this process, and the practice may be disrupted multiple times in numerous ways. Nurses can often be observed waiting on orders, making dozens of calls to verify the drug's status and location, and inspecting medication cabinets and bins repeatedly to verify if the medication has arrived on the unit. The results are delays in patient treatment and inefficient use of caregiver time.

These organizational failings are a primary source of added steps for nurses and give rise to questions regarding the physical location and characteristics of medication management. Technology solutions include advanced automated systems that use robotics to fill orders, bar code, and even deliver patient-specific medication rings to the nursing staff on each unit. The support of mini medication cabinets within the patient room has also been explored by some vendors; however these cabinets require individual fills for each patient. Creating closed-loop medication administration systems requires careful interdisciplinary thought in the context of all new construction and retrofit challenges (supply chain, informatics, work process, vendor platform integration). Facilities have also looked at the sequencing or organization of the work flow for the administration of medications as another promising solution. This category may represent the largest combined effect for improvements in patent safety and reductions in nursing time.

3. Communication

The positive benefits of timely, efficient, communication with and to the care team and the patient

and family (i.e., care coordination) have been well-documented (Gurses & Carayon, 2007; McCauley & Irwin, 2006; Pronovost, Wu, & Sexton, 2004; Sexton, Thomas, & Helmreich, 2000). Nurses spend an inordinate amount of their time calling, paging, locating physicians, and walking to the patient room to see what is needed by the patient. Indeed, care coordination was a major consumer of nurses' time in the Time and Motion Study (Hendrich et al., 2008). Nurses can be observed placing dozens of calls to communicate to a physician, department, or support area to deliver basic patient-care needs. These calls result in wasted time and delays in treatment; these communication delays or omissions may result in failure-to-rescue situations, in which a patient's condition is deteriorating.

The efficient flow of patient information and status updates could reduce wasted time, errors, and resource consumption for all caregivers. Some solutions include wireless networks, handheld, and ear devices that can be used to deliver patient information more quickly and directly. Intelligent systems that automatically track the physical location of a medical provider can be helpful if call schedules are kept current and if the provider is responsive to the call.

4. Supplies and Equipment

The interior core of the nursing unit contains multiple, small, adjacent functional rooms in nearly all hospital designs, and it is the reason for most steps taken away from the patient location. The RFID tracking of nurses during the Time and Motion Study revealed that the patterns and sequence of nursing activity are driven by the distance to and from functions within and around the core (unpublished data). Small functional spaces within the core are universal (clean/dirty utility, medication, supplies and equipment storage, laundry/linens, staff lounges, and kitchen/pantry areas). The nurse can be seen going from location to location, hunting and gathering the necessary equipment for care processes. This need for hunting and gathering often results in hoarding and over purchase of small capital equipment when a perceived supply shortage drives decision making. Equipment is often missing from the unit or has been moved to another location somewhere within the hospital, yet it often cannot be found in a timely way. Sometimes, this is the very equipment needed to

start critical intravenous medications, prevent blood clots in the lower extremities, or provide patient-controlled analgesia for pain relief.

A variety of innovations are being implemented and tested to address this need. Interventions range from low to high cost. On the lower end are bar codes for the most commonly used equipment that are tracked by an individual who rounds daily through the physical space and uploads data with a wireless device to a software program that stores the location of equipment. At the higher cost end is RFID-based tracking equipment and/or infrared technologies that can monitor equipment location and usage. The cost range for these interventions can be a few thousand to several million dollars.

The inefficiency of nurses' hunting and gathering equipment raises a larger and more important general question of how all supplies and equipment are managed within the organization. Decentralized options may reduce steps for the nurse but increase unit-based costs (filling/dispensing, wastage/contamination). Perhaps it is time to take a contrarian view: Can the core be eliminated? What if there was a centralized case-cart approach, not unlike the operating room, that provided 90% of what is predictable for the patient based upon his or her diagnosis? EHR data could be used to produce such a system for future care delivery.

Currently, expensive square footage within the hospital is being used to store and distribute supplies. It is time to look at the movement of hospital supplies differently. Industry models have long since solved this enormous area of overhead costs and waste. Open space in the center of the unit could be used to

provide gathering areas for families and shared space for staff to avoid isolation and promote social networking and communication among caregivers. Eliminating the core in favor of such open, shared space would allow for greater visibility and opportunities for visual connections.

This category represents a tremendous opportunity to reduce supply cost and increase caregiver productivity. Industry methodologies (lean/sigma) should be used to establish new supply and equipment distribution and delivery systems that improve turnaround times at the level of the nursing unit. Physical design innovation and the conversion of supply-chain distribution could lead to transformational change. Managing supply distribution that is patient-centric with EHR intelligence should be explored as a viable alternative to the costly, inefficient methods used by most hospitals.

PUTTING IT ALL TOGETHER:
TRANSFORMATION OF THE WORK ENVIRONMENT

The holistic integration of existing knowledge regarding hospital work environments and evidenced-based design can transform the quality of care delivery for nurses and patients. This approach to hospital organization and design represents a paradigm shift toward integration of each component into a holistic, interdepartmental strategic and operational plan with aligned capital. The goal of patient-centric care, part of the IOM report, can only be achieved when the work environment supports nurses and other healthcare workers in the efficient delivery of care, while providing a safe, healing environment for patients. The challenge going forward is to bring these many elements together simultaneously in the context of the current hospital building boom and within existing hospitals fraught with problematic work environments. This effort requires a commitment to consciously evaluate the work environment with these elements in mind and to test any new technology to determine its ability to integrate with the primary EHR platform. Solving the gaps in the four areas discussed will return significant nursing time to patient assessment and interventions, which, in turn, will serve to improve patient outcomes, increase staff satisfaction, and, ultimately, impact nurse retention and recruitment.

Sufficient data are now available to link professional nursing time with the categories of work processes identified in the Time and Motion Study.

Hospital executives and boards should challenge themselves to use this evidence base to transform the work environment of caregivers, improve hospital operations, and reduce the cost of care delivery. The CEO should avoid the temptation to address short-term demands with stop-gap measures that maintain organizational needs and limited successes. Long-term goals should be in place to transition the entire organization from the existing fragmented care delivery models to a fully integrated system that unites every aspect of the organization to support high-quality care. Improving the quality, reducing the cost, and increasing the reliability of healthcare will require a true interdisciplinary approach if real, sustainable, transformation is to occur.

REFERENCES

Aiken, L. H., Clarke, S. P., Sloane, D. M., Sochalski, J. A., Busse, R., Clarke, H., et al. (2001). Nurses' reports on hospital care in five countries. *Health Affairs (Millwood), 20*(3), 43–53.

Aiken, L. H., Clarke, S. P., Sloane, D. M., Sochalski, J., & Silber, J. H. (2002). Hospital nurse staffing and patient mortality, nurse burnout, and job dissatisfaction. *Journal of the American Medical Association, 288*(16), 1987–93.

Aiken, L. H., Sloane, D. M., & Sochalski, J. (1998). Hospital organisation and outcomes. *Quality in Health Care, 7*(4), 222–6.

Aiken, L. H., Smith, H. L., & Lake, E. T. (1994). Lower Medicare mortality among a set of hospitals known for good nursing care. *Medical Care, 32*(8), 771–87.

American Association of Critical-Care Nurses. (2005). *Standards for establishing and sustaining healthy work environments.* Retrieved April 20, 2008, from www.aacn.org

American Nurses Association. (2007). *Nationwide legislative trends (2001-2006), nurse staffing plans and ratios.* Retrieved August 15, 2008, from http://www.needlestick.org/GOVA/STATE/2006/staffing.htm

American Organization of Nurse Executives. (2004). *Principles and elements of a healthful practice/work environment.* Retrieved April 20, 2008, from http://wwwaone.org

Anderson, S. (2007). *Deadly consequences: The hidden impact of America's nursing shortage.* Retrieved May 12, 2008, from National Foundation for American Policy Web site at http://www.nfap.com

Centers for Medicare and Medicaid Services. (2006). *Eliminating serious, preventable, and costly medical errors—Never Events.* Retrieved April 17, 2008, from http://www.cms.hhs.gov/apps/media/press/release.asp?Counter=1863

Centers for Medicare and Medicaid Services. (2008). *CMS announces payment reforms for inpatient hospital services in 2008.* Retrieved April 17, 2008, from http://www.cms.hhs.gov/apps/media/press/release.asp?Counter=2335&intNumPerPage=10&checkDate=&checkKey=&srchType=1&numDays=3500&srchOpt=0&srchData=&keywordType=All&chkNewsType=1%2C+2%2C+3%2C+4%2C+5&intPage=&showAll=&pYear=&year=&desc=&cboOrder=date

Clarke, S. P., & Aiken, L. H. (2006). More nursing, fewer deaths. *Quality and Safety in Health Care, 15*(1), 2–3.

FMI. (2008). *FMI's construction outlook—second quarter 2008.* Raleigh, NC: FMI.

Gurses, A. P., & Carayon, P. (2007). Performance obstacles of intensive care nurses. *Nursing Research, 56*(3), 185–94.

Hendrich, A. (2003). *Optimizing physical space for improved outcomes: Satisfaction and the bottom line.* Paper presented at "Optimizing the Physical Space for Improved Outcomes, Satisfaction, and the Bottom Line," minicourse sponsored by the Institute for Healthcare Improvement and The Center for Health Design, Atlanta, GA.

Hendrich, A., Chow, M., Skierczynski, B., & Lu, J. (2008). A 36-Hospital Time and Motion Study: How do medical-surgical nurses spend their time? *The Permanente Journal, 12*(3), 25–34.

Institute of Medicine. (2004). *Keeping patients safe: Transforming the work environment of nurses.* Washington, DC: National Academy Press.

Jones, C. B. (2005). The costs of nurse turnover, part 2. *Journal of Nursing Administration, 35*(1), 41–49.

Jones, C. B. (2008). Revisiting nurse turnover costs: Adjusting for inflation. Journal of Nursing Administration, 38(1), 11–18.

Joseph, A. (2006a). *The impact of light on outcomes in healthcare settings.* Retrieved February 15, 2008, from The Center for Health Design Web site at http://www.healthdesign.org

Joseph, A. (2006b). *The impact of the environment on infections in healthcare facilities.* Retrieved February 15, 2008, from The Center for Health Design Web site at http://www.healthdesign.org

Joseph, A. (2006c). *The role of the physical and social environment in promoting health, safety, and effectiveness in the healthcare workplace.* Retrieved February 15, 2008, from The Center for Health Design Web site at http://www.healthdesign.org

Joseph, A., & Ulrich, R. (2007). *Sound control for improved outcomes in healthcare settings.* Retrieved February 18, 2008, from The Center for Health Design Web site at http://www.healthdesign.org

Kosel, K. C., & Olivo, T. (2002, April). *The business case for work force stability.* Voluntary Hospitals of America: Irving, TX.

Kovner, C., & Gergen, P. J. (1998). Nurse staffing levels and adverse events following surgery in U.S. hospitals. *Image: Journal of Nursing Scholarship, 30*(4), 315–21.

McCauley, K., & Irwin, R. S. (2006). Changing the work environment in ICUs to achieve patient-focused care: The time has come. *Chest, 130*(5), 1571–8.

O'Neil, E. (2007). *Healthcare workforce in the U.S. economy.* San Francisco: Health Workforce Solutions LLC.

Pronovost, P. J., Wu, A. W., & Sexton, J. B. (2004). Acute decompensation after removing a central line: Practical approaches to increasing safety in the intensive care unit. *Annals of Internal Medicine, 140*(12), 1025–33.

Rafferty, A. M., Clarke, S. P., Coles, J., Ball, J., James, P., McKee, M., et al. (2007). Outcomes of variation in hospital nurse staffing in English hospitals: Cross-sectional analysis of survey data and discharge records. *International Journal of Nursing Studies, 44*(2), 175–82.

Rogers, A. E., Hwang, W. T., Scott, L. D., Aiken, L. H., & Dinges, D. F. (2004). The working hours of hospital staff nurses and patient safety. *Health Affairs (Millwood), 23*(4), 202–12.

Sexton, J. B., Thomas, E. J., & Helmreich, R. L. (2000). Error, stress, and teamwork in medicine and aviation: Cross sectional surveys. *BMJ, 320*(7237), 745–9.

Trites, D. K., Galbraith, F. D., Sturdavant, M., & Leckwart, J. F. (1970). Influence of nursing-unit design on the activities and subjective feelings of nursing personnel. *Environment and Behavior, 2*(3), 303–334.

Tucker, A. L., & Spear, S. J. (2006). Operational failures and interruptions in hospital nursing. *Health Services Research, 41*(3 Pt 1), 643–62.

Ulrich, R., Zimring, C., Zhu, X., DuBose, J., Seo, H. B., Choi, Y. S., et al. (2008). A review of the research literature on evidence-based healthcare design. *Health Environments Research and Design Journal, 1*(3), 61–125.

U. S. Census Bureau. (2000). *Motherhood, the fertility of American women, 1900-2000.* Retrieved February 12, 2008, from http://www.census.gov/population/pop-profile/2000/chap04.pdf

Vahey, D. C., Aiken, L. H., Sloane, D. M., Clarke, S. P., & Vargas, D. (2004). Nurse burnout and patient satisfaction. *Medical Care, 42*(2 Suppl), 57–66.

GLOSSARY: DEFINITION OF KEY TERMS	
Term	**Definition**
Closed-loop medication system	A medication system that seamlessly links bar-coded unit-dose medications with computerized order entry, pharmacist validation, and positive patient identification, within an integrated storage and distribution chain to eliminate human errors and increase patient safety
Infrastructure	Technologies and systems used to support communication, documentation, medication administration, and the management of equipment and supplies
Interoperability	The ability of different technologies—such as data collection devices, etc.—to communicate, share data, and operate seamlessly
Work environment	The physical space, organizational structure, staffing, and culture of hospital units in which nurses work
Work processes	The processes that compose nursing practice, such as: • Admittance and discharge of patients • Patient assignment • Medication administration • Care coordination • Documentation
Workload	The demands of nursing practice, such as : • Length of shift • Nurse-patient ratio • Multiplicity of tasks • Distances traveled

TABLE 1: STANDARDS FOR HEALTHY WORK ENVIRONMENTS IN NURSING	
American Organization of Nurse Executives	**American Association of Critical-Care Nurses**
Collaborative practice culture	Skilled communication
Communication rich culture	True collaboration
A culture of accountability	Effective decision making
The presence of adequate numbers of qualified nurses	Appropriate staffing
The presence of expert, competent, credible, visible leadership	Meaningful recognition
Shared decision making at all levels	Authentic leadership
The encouragement of professional practice and continued growth/development	
Recognition of the value of nursing's contribution	
Recognition by nurses for their meaningful contribution to practice	

Adapted from: American Organization of Nurse Executives. (2004). *Principles and elements of a healthful practice/work environment.* Retrieved April 20, 2008, from www.aone.org; American Association of Critical-Care Nurses. (2005). *Standards for establishing and sustaining healthy work environments.* Retrieved April 20, 2008, from www.aacn.org

TABLE 2:

QUESTIONS TO FACILITATE CHIEF EXECUTIVE OFFICER ANALYSIS OF THE HOSPITAL WORK ENVIRONMENT

1	Does the physical space reflect evidence-based standards known to enhance caregiver and patient experience?
2	Are physicians and nurses co-managing the physical space and care-giving processes within the work environment?
3	Do all vendor contracts reflect interoperability standards and are they willing and active participants in the creation of the ideal work environment?
4	Do the current information technology (IT) and bedside monitoring systems support or detract from work-force efficiency?
5	Is the oversight committee for IT system selection interdisciplinary? Does the selection, design, and installation of IT systems incorporate the role of the clinician as a leader in the decision-making process?
6	Is there an effective asset management program that supports the caregivers to maximize efficiency of the care process while reducing waste and supply-chain cost?
7	Is a closed-loop medication system (bar codes, patient identification, unit dose, distribution) included in the IT strategic plan? Is the system designed from pharmacy to patient or from the patient/caregiver to the pharmacy?
8	Have you completed a facility space evaluation to quantify the cost of new or existing work environment and IT systems (pre- and post-installation) upon the caregiver process? Do they support or detract from caregiver productivity?
9	Do all facility planning groups include actual caregivers and patients in the design of any new facility or renovation?
10	How much of the CEO's time is spent on assessing the effectiveness of the playing field to understand the strengths and weaknesses that may detract from quality and cost?

TABLE 3: RECOMMENDATIONS OF ULRICH ET AL. FOR THE EVIDENCE-BASED DESIGN OF NEW HOSPITALS	
1	Provide all patients with private rooms that can be adjusted to address changing medical needs during their stays.
2	Improve indoor air quality with well-designed ventilation systems and air filters to prevent nosocomial infections.
3	Increase opportunities for cleaning hands.
4	Make hospitals quieter.
5	Provide better lighting and access to natural light to reduce stress and improve patient safety.
6	Create pleasant, comfortable, and informative environments to relieve stress and promote satisfaction among patients, their families, and staff.
7	Make hospitals easier for patients and their families to navigate.

Adapted from: Ulrich, R., Zimring, C., Zhu, X., DuBose, J., Seo, H. B., Choi, Y. S., et al. (2008). A review of the research literature on evidence-based healthcare design. *Health Environments Research and Design Journal, 1*(3), 61–125.

TABLE 4:
THE FOUR CATEGORIES THAT IMPEDE NURSING EFFICIENCY IN THE DELIVERY OF CARE

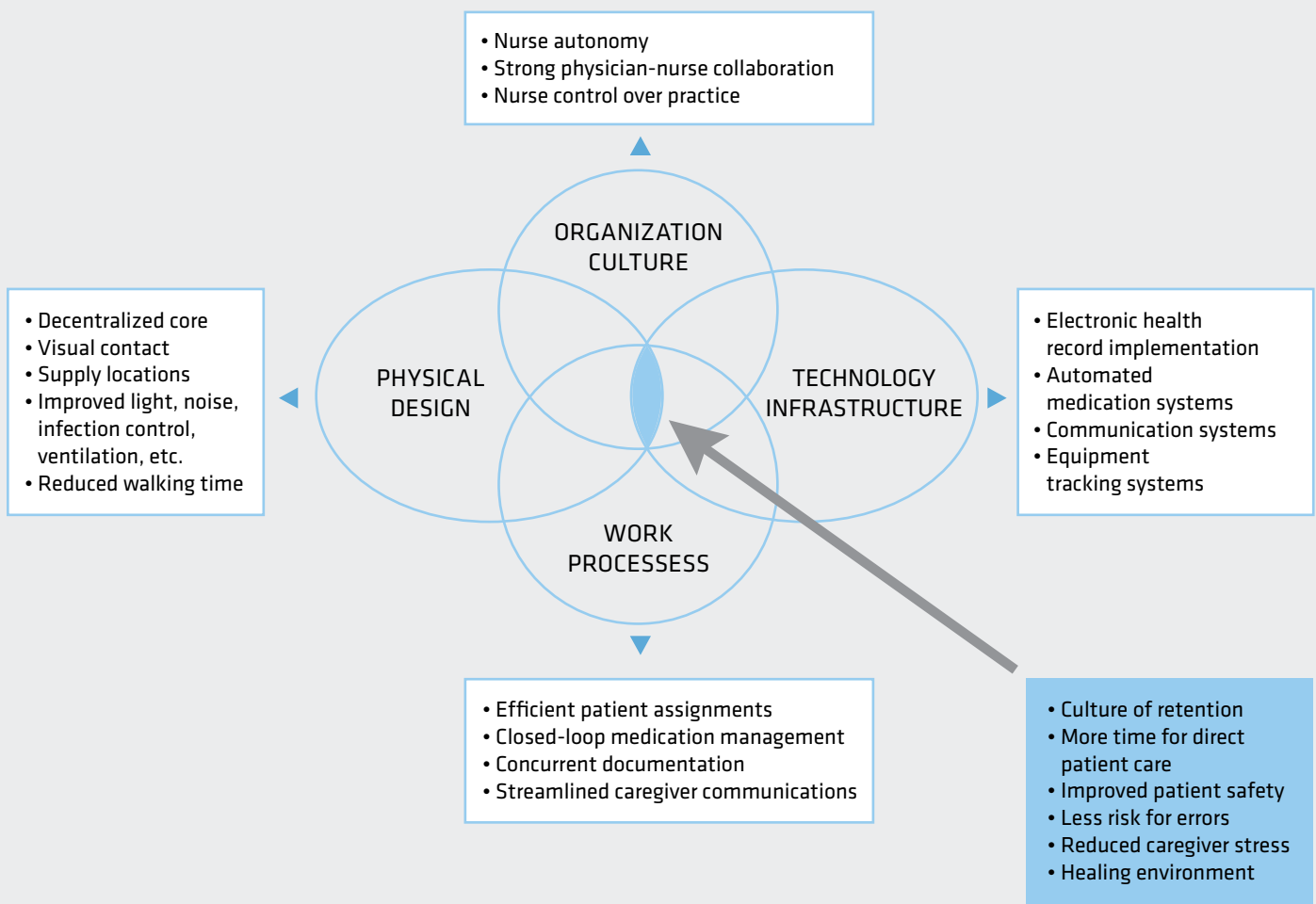| Category	Incremental Change	Transformational Change	Physical Environment Implications
Documentation	• Reduce paper forms • Avoid adding checklists in response to external or regulatory requirements • Integrate new requirements into existing documents and avoid duplication • Eliminate redundancy between disciplines • Standardize assessment forms to a single form	• Single patient-problem list for all disciplines • Single sign-on for all informatics systems • All data are entered at the point of collection • All bedside monitoring device data are automatically collected and transferred to the electronic health record • One handheld device displays, documents, identifies, and captures results reporting and patient level data • Documentation requires less than 10% of caregiver time	• Space for wireless printers with ease of access and reliable functionality • Multiple options for data entry to match personal preferences • Privacy and open access are balanced based on individual preference • Patient data-entry options can be accommodated during, pre- and post-episode of care treatments
Medication Administration	• Quiet zones for medication preparation • Cabinets are co-managed by nursing and pharmacy to assure reliability of efficient storage and location • Unit-dose bar-coded drugs • Order verification and order entry are linked to devices and cabinetry	• Closed-loop system with complete integration of computerized physician order entry, verification, bar coding, and location of drug with smart wireless devices and/or infusion pumps	• Expanded space requirements for robotics for automated fill systems • Noise levels with systems can be intense unless hardware space is separate from work areas • Wireless devices must be considered in network planning
Communication (Care Coordination)	• Wireless handheld and/or micro ear devices • Caregiver tracking and location • One call for physician location and/or call schedules	• Ubiquitous integration of communication devices with patient call-light system • Patient vital sign and physiologic data integration from bed, call light, and communication devices for automated alerts based on patient condition • Devices and alarm notification direct to caregiver with hands-free activation	• Wireless network requirements • Space for privacy balanced with open architecture and choice • Visual recognition merged with communication may require video conference space as part of care areas
Supplies and Equipment	• Decentralized storage in patient zone • Metrics and standards for turnaround time at the unit level established jointly by nursing and supply distribution • Bar code, radio-frequency identification, infrared tracking of vital equipment • Hoarding is reduced with asset management • Excess equipment and idle time is diminished	• Case cart approach for each patient driven by data • All supply storage and distribution moved away from the patient-care units • Robotic distribution of case carts with wireless order entry for random variation requests	• Elimination of the nursing core requires transformation of traditional spaces to novel solutions • Off-nursing-unit supply-chain distribution and management should be explored • Equipment-locating software stations must be considered

APPENDIX:

THE 36 SITES INCLUDED IN THE TIME AND MOTION STUDY*

Health System	Study Site Facility	Location
Ascension Health	Brackenridge Hospital	Austin, TX
Kaiser Permanente	Baldwin Park Medical Center	Baldwin Park, CA
Ascension Health	St. John Hospital and Medical Center	Detroit, MI
Kaiser Permanente	Anaheim Medical Center	Anaheim, CA
Ascension Health	Borgess Medical Center	Kalamazoo, MI
Kaiser Permanente	Riverside Medical Center	Riverside, CA
Ascension Health	Columbia St. Mary's	Milwaukee, WI
Kaiser Permanente	Los Angeles Medical Center	Los Angeles, CA
Ascension Health	St. Vincent's Medical Center	Jacksonville, FL
Kaiser Permanente	West Los Angeles Medical Center	Los Angeles, CA
Ascension Health	St. Vincent's Hospital	Birmingham, AL
Kaiser Permanente	Panorama City Medical Center	Panorama City, CA
Ascension Health	St. Thomas Hospital	Nashville, TX
Kaiser Permanente	South Sacramento Medical Center	Sacramento, CA
Mercy Health System	Mercy Health Center	Oklahoma City, OK
Kaiser Permanente	San Francisco Medical Center	San Francisco, CA
Carolinas HealthCare System	Carolinas Medical Center	Charlotte, NC
Kaiser Permanente	South San Francisco Medical Center	South San Francisco, CA
Duke University Health System	Duke University Hospital	Durham, NC
Kaiser Permanente	San Rafael Medical Center	San Rafael, CA
Moses Cone Health System	Wesley Long Community Hospital	Greensboro, NC
Legacy Health System	Legacy Mount Hood Medical Center	Gresham, OR
Vanderbilt	Vanderbilt Medical Center	Nashville, TN
Kaiser Permanente	Redwood City Medical Center	Redwood City, CA
Henry Ford Health System	Henry Ford Wyandotte Hospital	Wyandotte, MI
Intermountain Healthcare	Utah Valley Regional Medical Center	Provo, UT
Trinity Health	St. Joseph Mercy Oakland	Pontiac, MI
Aurora Health Care	Aurora West Allis Medical Center	West Allis, WI
Kaiser Permanente	Santa Clara Medical Center	Santa Clara, CA
Inova Health System	Inova Mt. Vernon Hospital	Alexandria, VA
New York-Presbyterian	Columbia University Medical Center	New York, NY
Saint Barnabas Health Care System	Monmouth Medical Center	Long Branch, NJ
North Shore-Long Island Jewish Health System	Long Island Jewish Medical Center	New Hyde Park, NY
Kaiser Permanente	Fremont Medical Center	Fremont, CA
Christiana Care Health System	Christiana Hospital	Newark, DE
Kaiser Permanente	Hayward Medical Center	Hayward, CA

***Note that sites are listed chronologically by study date.**

FIGURE 1:

THE INTERFACE BETWEEN UNIT PHYSICAL DESIGN, ORGANIZATIONAL CULTURE, TECHNOLOGY, AND WORK PROCESSES IN CREATING A CULTURE OF RETENTION AND SAFETY

- Nurse autonomy
- Strong physician-nurse collaboration
- Nurse control over practice

ORGANIZATION CULTURE

- Decentralized core
- Visual contact
- Supply locations
- Improved light, noise, infection control, ventilation, etc.
- Reduced walking time

PHYSICAL DESIGN

TECHNOLOGY INFRASTRUCTURE

- Electronic health record implementation
- Automated medication systems
- Communication systems
- Equipment tracking systems

WORK PROCESSESS

- Efficient patient assignments
- Closed-loop medication management
- Concurrent documentation
- Streamlined caregiver communications

- Culture of retention
- More time for direct patient care
- Improved patient safety
- Less risk for errors
- Reduced caregiver stress
- Healing environment

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