A Participatory Design Process Addressing Ergonomics in Hospital Patient Rooms

FINAL REPORT

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List of Terms and Abbreviations

Med/Surg Patient Rooms – Patient rooms designed for Medical/Surgical patients.

ABSTRACT

In many workplaces the awkward postures and motions exhibited by workers, and the effort required to complete work-related tasks, bear a direct relationship to the layout and organization of the workspace. Hospital patient rooms are workplaces for many occupational groups, many of which find themselves working in physically demanding ways due to the design of these rooms. The long term goal of line of research is to reduce musculoskeletal injuries and discomfort experienced by healthcare workers in institutional settings. *The primary goal of this research project was to address the needs of the all the stakeholder groups working in medical/surgical (med/surg) patient rooms through a systems approach, largely driven by a participatory design process.* In the first phase of this work, 147 people, representing 23 different hospital-based occupational groups, participated in focus groups and interviews where they discussed the work they do in med/surg patient rooms and what aspects of room design make their work more difficult physically. The analysis of these data were stratified by the different phases of the work process specifically when they enter the room, as they prepare to perform their tasks within the room, as they perform their tasks within the room, and as they prepare to and leave the room. In the second phase of this study, 104 individuals from 24 occupations, worked in mixed occupational groups, at full scale, to create their ideal med/surg patient room. Twenty-seven sessions yielded 27 room designs, which were grouped into five categories, based on bed and bathroom location similarities. A hybrid room design was then created to represent each of the five categories and present many of the innovative ideas of the participants. The five hybrid layouts were then shown, at full scale, to patients and their visitors/family member in the third phase of the study, because while we are trying to optimize these workplaces for hospital staff, they need to also meet the needs of the room occupants. The 37 patients and 24 visitors/family members provided rich qualitative data highlighting their needs within these spaces. The fourth and final data collection phase comprised reviewing the hybrid layouts with staff to discover (1) which design features were liked and disliked, (2) where there were design conflicts between different occupational groups, and (3) where there were design conflicts between occupational groups and the patients or visitors. This research process yielded a set of 66 guidelines that capture the design needs and innovations across all phases of the study. These guidelines should enable designers, planners, hospital administrators, and others interested in patient room design to make informed design decisions during new hospital construction and remodeling projects, and lay the groundwork for future evidence-based research related to healthcare facility design.

Section 1 (2 page limit)

SIGNIFICANT OR KEY FINDINGS

Several findings are presented in this report that could significantly improve the ergonomics of Medical/Surgical (Med/Surg) patient rooms. The following bulleted list is organized by the four principal phases of the project:

Phase I: Understanding Issues with Current Spaces

- Many of the hospital workers who perform tasks in Medical/Surgical (Med/Surg) patient rooms are working in environments where space is extremely limited which results in adoption of awkward working postures, additional work tasks (e.g. furniture moving), and less efficient work processes.
- There typically is not enough horizontal surface space in close proximity to the patient that is available for staff use.
- Med/Surg patient rooms where the patient cannot see staff entering the room are disliked by staff and by patients.
- Locations of personal protective equipment (PPE), hand sanitizer, and light switches should be standardized for all patient rooms in a facility.
- Often it is difficult to find a place to sit when hospital staff need to have eye level conversations with patients.
- The staff who assist patients with toileting and bathing indicate many challenges due to limitations in bathroom design including overall size, door configuration, and fixture placement.

Phase II: Ideal Room Design

- Through a full-scale mock-up design process members of hospital staff who participated in the study communicated what their ideal patient rooms would look like and what design features would make their work physically easier within these spaces.
- From 27 initial designs, five “hybrid” room layouts were created that appear to meet the expressed needs of hospital staff and address the staff’s need to reduce the physical effort required from them when working in med/surg rooms.
- The resulting hybrid room designs contained several innovative concepts that focused on room features, storage solutions, furnishings, electronics, the tray table, the family area, lighting, hygiene, and features that would facilitate nursing.

Phase III: Patient and Visitor Needs

- Patients and visitors reviewed the layouts, suggested changes, and discussed their needs within the med/surg patient room.
- In addition to being comfortable, feeling secure, and having an environment that supports recovery, patients talked about their needs to connect with family, home, and the outside world; to have access to their things, the bathroom, and visibility with

visitors; and to have control over their environment in terms of the lighting, temperature, noise, and security of their belongings.

Phase IV: Design validation and Conflict resolution

- Staff reviewed concept rooms, validated their usability, and provided insights into potential design conflicts that need to be considered by designers of healthcare facilities.

TRANSLATION OF FINDINGS

The product of the four-phase research process described in the body of the report, is a set of 66 design guidelines. These guidelines have been written for the intended audience of architects, facility designers, and interior designers who work on different aspects of the patient room and should be applicable to both new hospital construction as well as remodeling projects. The guidelines, organized by primary and secondary room design features within the different areas of the room (entry, patient/clinical area, family area, bathroom), include the rationale for each guideline from both the staff and patients' perspectives, and constraints that need to be considered when implementing the respective guideline.

RESEARCH OUTCOMES / IMPACT

The outcomes associated with this work should be enhanced ergonomics in the work environment and improved efficiency of hospital staff as they work in med/surg patient rooms. Patient room designs that enhance staff efficiency reduce perceived time demands and the physical and psychological stress that is associated with time demanding and inefficient work processes. Some of the design guidelines are intended specifically to reduce the physical effort of staff, thereby improving staff safety and musculoskeletal health. Given that the guidelines developed through this research process have just been released, via this report and via a recent presentation at the 2017 Healthcare Design Conference (Orlando, November, 2017), it is not possible to say just yet how they have affected or will affected design practice. Survey feedback from conference attendees indicated that many of the guidelines would be easy to implement going forward and some attendees indicated that they already comply with some of the guidelines presented. We envision that these evidence-based guidelines will be adopted by designers as we continue to communicate their existence to healthcare facility designers and their customers, namely hospital administrators, who desire the development of effective patient rooms designs created as part of new construction or remodeling projects.

Section 2: Scientific Report

Background

Of the ten sectors of private industry listed by the U.S. Bureau of Labor Statistics (BLS), Education and Health Services ranks second in number of reported nonfatal lost time injuries and illnesses (BLS 2016; Resource Table R44). In 2016, about 80,000 injuries were experienced by workers who interact with patients or are likely to work part of the time in patients' rooms. About 54% of those injuries occurred to nursing aides and attendants, 26% to RNs, 5% to janitors and housekeeping staff, 5% to therapists and their aides, 3% to imaging technologists, and 7% to LPNs. Incidence rates of lost time injuries range from about 70 to over 300 cases per 10,000 FTE across these occupations (BLS 2016, table R99). Healthcare patients are designated as the source of injury for RNs and many other direct patient care occupations, including LPNs, nursing aids, therapists and aids, and imaging technologists. A number of epidemiological studies of work-related musculoskeletal injuries in healthcare workers have also identified the patient as an important injury risk factor (Engels *et al.* 1996, Josephson *et al.* 1997, Smith *et al.* 1997, Russo *et al.* 2002). Worker motion, floors, machines, and furniture also contribute to injuries to people who provide direct or indirect patient care in hospital settings (BLS 2016). Injury rates due to overexertion are common across all of these occupations (RNs, imaging technologists, janitors, etc.), with rates ranging from about 30 to about 175 cases per 10,000 FTE (BLS 2016; table R100). These sources and types of injuries also affect workers employed in government healthcare settings (e.g. county hospitals and VA facilities) (Menzel 2008), who are not counted in the aforementioned statistics. Overall the costs to individuals in terms of disability, to organizations in terms of workers compensation, reduced efficiencies, and care quality, and to a society trying to control out-of-control healthcare costs are tremendous and present an important research-to-practice opportunity.

Many researchers have addressed this problem by investigating patient handling tasks and the use of patient handling equipment. One research area that has received relatively little attention, however, is the design and layout of patient rooms (Hignett and Lu, 2010). As Hignett and Lu (2010) point out in their review of design recommendations made between 1866 and 2008, only one out of 34 recommendations was based on empirical evidence stemming from classical work analysis techniques. But as Hignett and Lu (2007) noted in their work with Intensive Care Unit (ICU) rooms, the patient rooms are "the most important and largest repeating space envelop in a health care facility" and are the center of much nursing and patient care activity therein emphasizing the need for further investigation into the ergonomic issues that can be addressed through patient room design. Historically, the lack of focus on this area by ergonomics researchers may be understandable, given the life span of hospital facilities and the limited opportunities for change. However, as we emerged from the recent economic recession a construction boom was underway in the healthcare sector (Gamble, 2011; Nelson et al., 2005; Terry, 2011). This presents an unprecedented opportunity to provide evidence-based ergonomic guidance to those who design patient rooms at a time

when that guidance can readily be incorporated. The decisions designers make as they create these new healthcare environments will significantly impact the way work is done and consequently the health and safety of healthcare workers and hospital staff for many years to come. The significance of this research project is that it addresses the paucity of evidence-based ergonomic guidelines available to *those who design healthcare facilities.* When writing the grant application for this project we fully expected that the in-depth participatory research process that we described, in addition to addressing the ergonomic needs of those who provide services in hospital rooms, would enhance the efficiency of nurses and other healthcare workers as well as those who provide exclusively indirect patient care (e.g. housekeepers), therein potentially lowering per patient costs; improving the patient's and family's experience, and positively impact patient safety. The results from this research could be used to ensure that the next generation of patient rooms are free from many of the systematic design flaws that can be propagated through standardization of patient care units. There is currently substantial construction in the healthcare sector. Thus there is a need for evidence-based recommendations for room designs that meet the needs of all stakeholders providing patient care and services in these rooms.

Four emerging trends in healthcare will impact the design of hospital rooms. First, there is a trend toward acuity–adaptable rooms which can be configured to accommodate the needs of patients as they progressively regain their health. There is evidence demonstrating the value of this design philosophy with regards to measures of operational cost, patient safety and error reduction, and patient satisfaction levels (Hendrich, Fay, & Sorrells, 2004). Second, there is a trend towards the provision of in-room clinical services rather than transporting patients throughout the healthcare facility to obtain these services in the hospital's clinics (Patel *et al.* 2006). Both of these trends signify that there will be more healthcare workers and hospital staff providing services in patient rooms of the future. Third, largely driven by infection control, new patient rooms within the United States are single patient occupancy. Fourth, patients are getting heavier, reflecting a trend in the general population. This means larger beds, larger furnishing for visitors resulting in and less work space for healthcare workers and hospital staff to use in performing their respective tasks, as well as many of those tasks being more strenuous due directly to the patient's weight. These trends therefore indicate the need to develop evidence-based guidelines for designers of healthcare facilities that address the ergonomic needs of healthcare workers and staff, while at the same time considering the environmental, social and cultural design needs of families and visitors.

Specific Aims

The objective of this research was to develop room design guidelines specifically focusing on the design of medical/surgical (Med/Surg) and acuity-adaptable patient rooms. The overarching research hypothesis is that the design of the patient room, which includes physical size and shape of the room, the layout of the furniture, and the task-based components, affects the way work is performed in the room, which in turn affects productivity, worker health and safety, and patient outcomes. Therefore, this research addressed the following **four specific aims** which correspond with the four phases of this project**:**

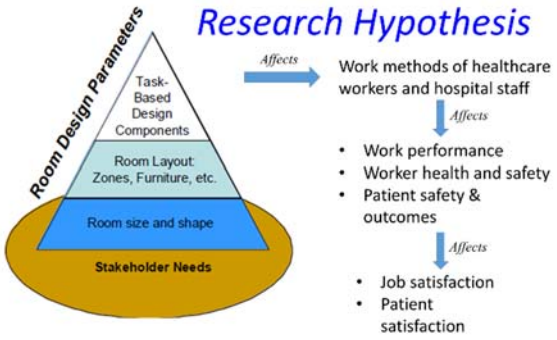


Figure 1. Impact of patient room design.

1. Identify, observe, and analyze work tasks that, due to patient room design parameters, ergonomically challenge the identified stakeholders (users).
2. Obtain consensus on the ergonomic challenges associated with patient room design and elicit stakeholder-specific recommendations regarding ergonomic aspects of patient room design.
3. Identify patient room design parameters that impact the needs of patients and their visitors and family members, and elicit alterations in patient room design parameters that best support those needs.
4. Resolve conflicts between stakeholder groups with regard to patient room design parameters, thereby, allowing for a clear set of design parameter recommendations for patient rooms.

The product of this work is a set of guidelines that will allow healthcare facility designers to address the ergonomic needs of all stakeholders who provide patient care and services within a patient's hospital room. As these guidelines are incorporated into new and remodeled facility designs, employee safety, health, and efficiency should be positively impacted, without compromising patient care. This study was approved by the Institutional Review Board of The Ohio State University.

PHASE I: UNDERSTANDING ISSUES WITH CURRENT SPACES

Aim 1: Identify, observe, and analyze work tasks that, due to patient room design parameters, ergonomically challenge the identified stakeholders (users).

Research overview. Focus groups and interviews were conducted with individuals from 23 stakeholder groups working at a large urban academic medical center in the United States.

Private and semi-private medical-surgical (med/surg) patient rooms are used at this medical center which, including the bathroom space ranging in size from 18.2 to 30.7 m^2 for the single occupancy rooms and from 29.9 to 37 m^2 for the double occupancy rooms. The focus group and interview sessions were designed to elicit each individual's primary issues with med/surg patient room designs. Most of the focus group sessions were comprised of single (homogeneous) stakeholder groups. Exceptions included combined groups of physical and occupational therapists, a group with technicians who perform different imaging modalities, and groups with both nurses and patient care assistants (PCAs). Following the sessions, individuals from several stakeholder groups were observed while working.

Participants. Across the 23 occupational stakeholder groups, 147 people elected to participate in either a focus group or an interview. Table 1 shows the distribution of the sample across the stakeholder groups and a description of each group's primary function within the patient room. Additionally, 43 individuals were observed so that we could better understand the tasks they perform in the patient rooms.

Procedure. Participants were recruited via short presentations given by the investigators at stakeholder group staff meetings and via posted flyers. Where possible, participants were scheduled for focus group sessions. Individual interviews were conducted where the selected focus group times were not feasible for individual participants or where it would be especially difficult to coordinate schedules for a focus group (e.g. hospitalist physicians).

Table 1. The stakeholder groups recruited for this study and their primary job responsibilities within the patient room. The sample size ("n") indicated the number of participants within each stakeholders group that participated in focus groups or interviews. The number in the parentheses indicates the number that were observed.

Stakeholder category	**Stakeholder group**	**n**	**Primary job responsibilities within the patient room**
Patient care	Hospitalist physician	6 (3)	Check in with patient daily to assess their health conditions: sometimes do procedures, also meet with family members to discuss plan for the day.
Patient care	Nurse	17 (5)	Provide nursing care. Includes medication administration, dressing changes, and pain assessment.

Patient care	Patient care assistant	10 (2)	Assist nurse with providing patient care and responding to patient call light, take vital signs, change sheets, assist patient with toileting and bathing.
Patient care	Safety care associate (sitter)	3	Protect patient's safety, eliminate safety risks, help patient. with personal care (assist with toileting, bathing and grooming), help care providers if necessary
Patient care	Case manager	2 (1)	Meet with patients in patient room to discuss discharge planning
Patient care	Patient transporter	10	Move patients to and from room to other locations throughout the hospital.
Therapist	Physical therapy	11 (4)	Get patient ready to move, get out of bed, sit in chair, walk in hall, use the stairs, etc.
Therapist	Occupational therapy	9	Get patient ready for safely taking care of themselves at home: get out of bed, sit in chair, go to bathroom, etc.
Therapist	Respiratory therapist	5	Provide patients with assistance in breathing either through mechanical assistance, pharmaceuticals, or education.
Therapist	Speech language pathologist	4 (3)	Provide oral/swallow evaluation, oral/swallow therapy session, and general care for patients with speech and swallowing disorders.
Nutrition	Dietitian	5 (3)	Assess patient’s diet, determine meal plans for patients, and educate them on nutrition.
Nutrition	Dietetic technician	5 (2)	Do the meal selections for complicated diets and consult and educate patients.
Nutrition	Nutrition aides (food service worker)	7 (3)	Get meal orders from patients and deliver food to them.
Imaging	Echocardiographer/ Cardiac sonographer	5	Obtain cardiac ultrasound images using a portable ultrasound machine that they bring into the room

Imaging	Sonographer	4	Obtain ultrasound images using a portable ultrasound machine that they bring into the room
Imaging	Vascular technologist	2	Obtain vascular ultrasound images using a portable ultrasound machine that they bring into the room
Imaging	Radiographer	7 (5)	Obtain x-ray images using a portable x-ray machine that they bring into the room
Housekeeper	Housekeeping	10 (4)	Clean and disinfect the patient room. Includes routine (daily) clearing, discharge cleaning and the cleaning of isolation rooms.
Engineering	Clinical engineer	8 (6)	Fix or replace electronic medical equipment used in the patient room.
Engineering	Building operation	3	Maintain heating and cooling ventilation systems and maintain med gases.
Engineering	Zone technician	3	Provide immediate room repairs that include fixing the: plumbing, lighting, electrical supply, window coverings, as well at mounting white boards, hand sanitizers, hooks in closets.
Engineering	System shop	2	Maintain electricity and drywall.
Engineering	Mechanical shop (plumber)	4	Maintain water and gas infrastructure.
Engineering	Construction Tech	1	Does repair work within the facility.
Information Technology	Varied	4	Responsible for computers and data access in the patient rooms.

Prior to attending the focus group and interview sessions, most of the participants were asked to complete an online survey designed to sensitize them to the topics that would be discussed during the meetings. Specifically, the survey queried participants about interactions they have had with many of the objects and items normally present in hospital patient rooms. As part of this survey process, participants were encouraged to upload photographs without patients that illustrated where the interactions with objects and items in their patient rooms were problematic for them. Engineers and housekeepers were not asked to complete the

survey due to the non-clinical nature of the work they perform. Hospitalist physicians were not asked to complete the survey in order to minimize their time commitment.

As participants arrived for the session, each reviewed and then signed an approved informed consent document. After introductions, the participants were shown a series of photographs, some of which had been submitted by the research participants, and others that were taken by the researchers to illustrate particular areas of interest, in case participants' photos did not include images of every topic we wanted to discuss with them. The photos were used to initiate the conversation regarding the participants' issues and concerns with the setup and design of the patient rooms in which they work. When participant photos were available these were always used, because the participants could use these to clearly describe their issues. During this discussion, members of the research team wrote, on sticky notes, issues that were described by the participants. This discussion phase typically lasted about 30 minutes for the interviews and about 60 minutes for the focus groups. Following the discussion, the participants were shown the issues documented on the sticky notes and they were asked to cluster issues according to common themes defined by the participants with assistance from the session moderator. Once each note was placed in a cluster and the clusters were named, the participants were provided with five votes, in the form of five adhesive-backed colored paper dots. The participants were instructed to place the adhesive-backed dots on the clusters or on specific issues that were most important to them. The participants were instructed that their one blue dot was worth four voting points. The remaining red dots were worth one voting point each. Once the participants voted with their dots, the moderator reviewed the placement with the participant(s) to reiterate the key issues and assess the degree of consensus within the focus group. All discussions were audio recorded and professionally transcribed.

Data Analysis. Qualitative analysis methods were utilized to analyze audio transcripts, issue cluster diagrams, survey data, and observational data. Initially, three members of the research team analyzed the data of one stakeholder group, in order to establish an analysis framework that could be applied to the data of the other groups. After reviewing all of the data for the initial group, the three team members proposed a few different analysis frameworks to the whole research team and consensus was reached on one that organized the data temporally based on the tasks and subtasks the worker performed in the patient room. Each subtask would be classified as occurring during one of four temporal stages: entering the room, preparing to perform the task that was the reason he/she came into the room, doing the task, and preparing to leave the room. Think of the subtasks as column headings in a spreadsheet. The other dimension of the analysis framework that emerged from the data were categories of issues (difficulties) associated with performing the tasks and subtasks in the patient room; think of these issue categories as the rows in the spreadsheet. The issue categories were: challenges to doing the subtask due to room design elements, physical obstructions encountered in the room, and what was needed but not provided in/by the room. After the analysis framework was developed, each member of the research team took the lead in the initial analysis of the data for one or more stakeholder groups. Each initial analysis was subsequently presented to

and discussed by the entire research group. Consensus was reached before finalizing the analysis of the data of every stakeholder group.

Issues were associated with four work phases: (1) *entering the patient room*, (2) *preparing* to do the intended activity(ies) within the room, (3) *doing* the activity(ies) that was (were) the reason for entering the patient room, and (4) *leaving* the patient room. Our operational definition of "entering" included all the room element interactions encountered before entering the patient care area (patient zone). Likewise, our operational definition of "preparing" included all the activities done between the time the stakeholder entered the patient zone and the initiation of the activities in the doing phase. This might include moving furniture to clear a pathway or gain access to the bedside, positioning a computer, plugging in portable equipment brought into the room temporarily, adjusting lighting, etc. "Doing" was operationally defined as completing the stakeholder's primary activities within the room. "Leaving" included the activities such as disposal of personal protective equipment (PPE), performing exiting hand hygiene protocols, etc. performed just prior to exiting the room. The issues posed by the room design elements that were identified in each of these four work phases were then compared across stakeholder groups to identify issues that are common to several stakeholder groups and challenges that are group-specific.

RESULTS

Entering the Room. Figure 2 summarizes the challenges the different stakeholder groups reported that they had while entering patient rooms. Some of the more common issues included room designs that make it difficult for patients to see anyone entering the room and, as a result, staff may startle patients when they enter the room, entering through doorways that are narrow relative to portable equipment that staff bring into the room, navigating entryways cluttered with items such as bins for soiled laundry and trash receptacles, locating and accessing PPE, and issues associated with hand hygiene such as inconvenient or inconsistent hand sanitizer locations, sink locations that are not near the door or in view of the patient, and the lack of a designated staff sink. Consistent with the theme of not being able to see the patient, was the inability to see what is going on in a patient's room before entering. This was especially noted for isolation rooms where PPE has to be donned before entering, which could be a waste of time if the staff member entered the room and then determined the patient was not in the room. Double occupancy rooms at the medical center where the study was conducted were set up in three different ways. In some rooms the beds are oriented such that patients look directly at one another. In other rooms the beds are oriented parallel to one another. However, in the latter case the beds may be oriented such that the patients are

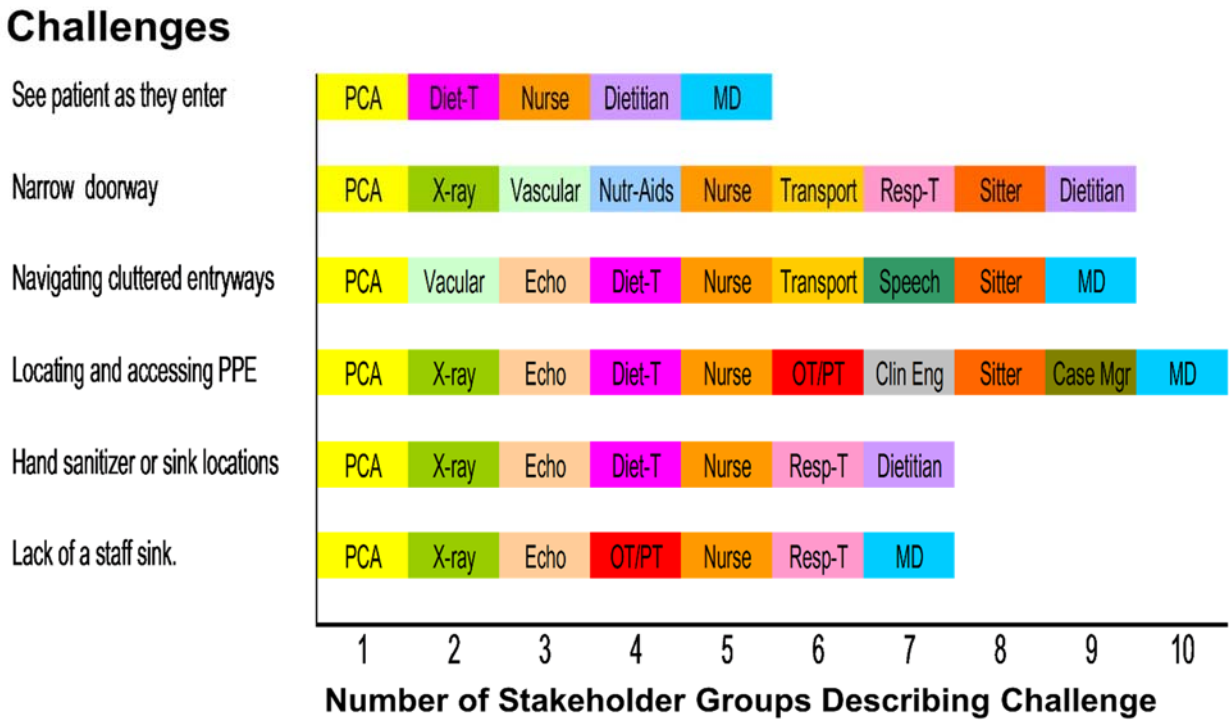


*Figure 2. Challenges expressed by staff that they face when **entering** the patient room.*

looking at a side wall, or the beds may be oriented so the patients are looking out the window with the room door essentially behind them. Three stakeholder groups noted the lack of a

consistent system for identifying the patients, based upon bed location, when they entered double occupancy rooms.

Preparing. Entering the patient zone, which characterizes the beginning of the preparing phase, was challenging for many of the stakeholder groups (Figure 3). The limited space in the room and around the bed was identified as an issue by 15 of the 23 stakeholder groups, posing challenges that result in reduced job performance efficiency and additional physical effort. Nine stakeholder groups specifically mentioned the time and effort to move things and the lack of space for moving things. For example, several stakeholders indicated they often had to rearrange the furniture and other items in the room in order to get themselves and their equipment into position next to the bed. In many cases, this was due to the overall lack of space in the room which made it difficult to move things that were in the way to a position where they would be out of the way. The definition of what was in the way as opposed to out of the way depended on the stakeholder group. Nursing staff wanted to have clinical care supplies, equipment, and disposal locations within easy reach of the patient bed, whereas physical therapists, occupational therapists, and patient care assistants needed to have a clear

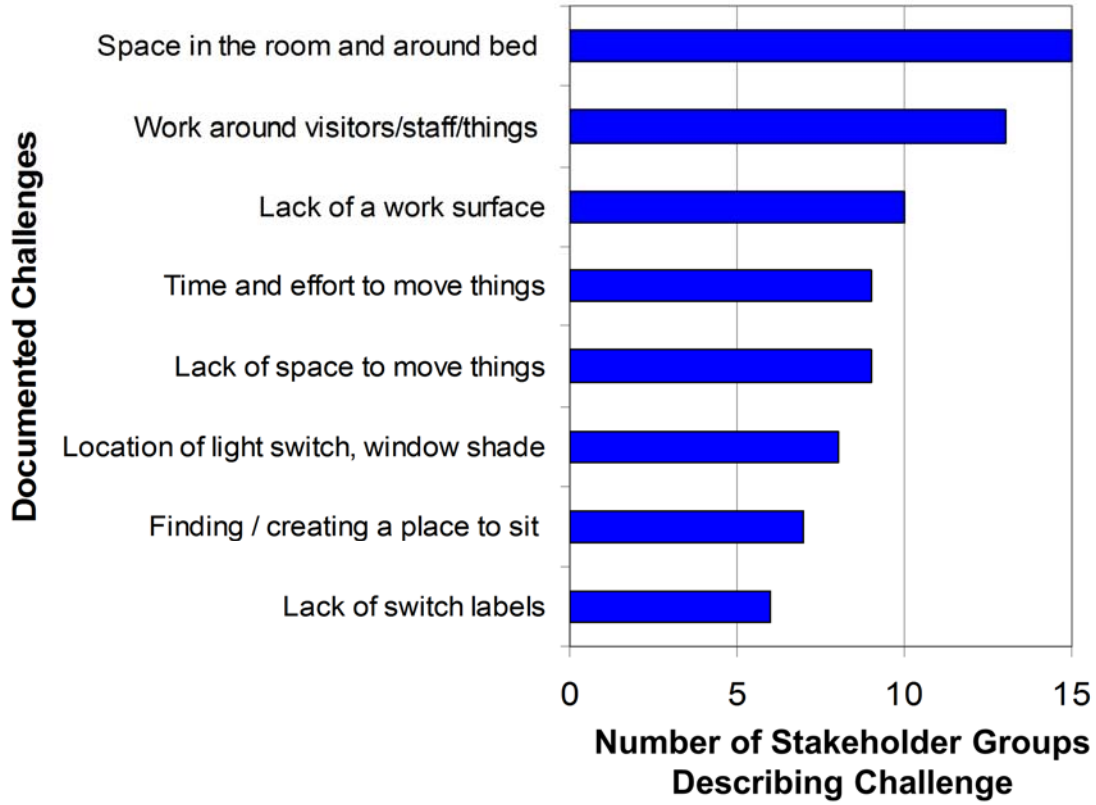


*Figure 3. The challenges staff face when **preparing** to do their primary tasks within the patient room.*

path from the bed to the bathroom, recliner chair, or hallway. Imaging technologists and transporters needed to bring transporter beds or wheeled equipment carts directly next to one side of the patient bed. Likewise, the beds and equipment being brought into the room, for example portable imaging equipment, tended to catch on protruding features like door handles and things that could not be moved far enough out of the way. Within the category of "time and effort to move things", once the stakeholders were in closer proximity to the patient, the various cords (power cords for bed, IV equipment, and patient electronics, as well as cord to nurse call button) lying on the floor near and under the bed interfered with positioning the equipment brought in by the staff members and made it difficult to move the over-bed table out of the way; these cords also create trip hazards for staff and patients.

The challenges of limited space were more salient when participants described their experiences in double rooms where the patients were separated by a privacy curtain. Imagining technologists voiced concerns about disturbing the other patient in the room, catching their equipment on the curtain, touching the curtain (a hygiene concern) as they were working and getting their equipment into position, and bumping into objects and people on the other side of the curtain.

Space was also an issue in discussing the location of supplies. In preparing for their clinical activities, nurses and PCAs reported being challenged by the location and availability of supplies, within the patient rooms, that they needed to complete patient care activities.

Seven stakeholder groups indicated they would like to sit during their interactions with patients. Many indicated a desire to be "at eye level" with the patient. This makes conversations more pleasant, but can also provide physical relief for the worker (sit v. bending the spine to come closer to the patient, and giving the lower extremities and back a break from standing. However, finding a chair or creating a place to sit was reported to be a significant challenge for these stakeholder groups.

In getting ready to provide clinical care, several stakeholders reported they needed to adjust lighting levels in the room. This could be challenging due to light switches that were not easily accessible or that are not labeled with their function. In the case of double rooms, switching on the wrong light could disturb the other patient.

Some of the stakeholder groups that bring equipment into the room, for example imaging equipment, indicated they were challenged by a scarcity of electrical outlets and their inaccessible locations. This scarcity was exacerbated by the competition with patients and their visitors for outlets as they bring more electronic devices from home into the rooms.

Ten stakeholder groups identified the lack of a work surface available to them in the patient room. The rolling over-bed table would be convenient for their activities, however, in many cases this was covered with patient-related items (food tray, water pitcher, reading material, patient's computer, personal items, etc.). Moreover, there were many different makes and models of over-bed tables which lead to operability and usability issues. When the

over-bed table had to be moved, the challenge of limited space reappeared. Specific issues included interference between the table's wheels and power cords on the floor under the bed, making the task more physically strenuous, and the question of where to place the over-bed table once it was moved, given the limited open space in the rooms.

In addition to lack of space in the patient room, lack of space in the patient's bathroom and around fixtures was identified in six stakeholder groups which included Nurses, PCA's, OT/PT, Housekeeping, Safety Care Associates (sitters), and those fixing the plumbing from the Mechanical Shop. Zone Techs, who take care of minor plumbing issues, particularly during the overnight periods, described the challenges of getting into the bathroom without waking a patient when the bathroom was on an outer wall, far from the entry to the patient's room, as well as the challenges of accessing the plumbing under the sink.

Doing the Activity. Table 2 summarizes the primary room design challenges facing each stakeholder group as they perform their primary activity(ies) in the patient room. Table 2 indicates that for 10 of the stakeholder groups the primary challenges are the limited access and amount of space available in the room, even though these affect different stakeholder groups in different ways. Sonographers need to position themselves and their equipment in specific orientations to obtain the highest quality image possible while not incurring an injury as a result of scanning in postures that are physically awkward and uncomfortable to the point of injury. This requires sufficient access to both sides of the patient bed. It is recommended that two radiographers should perform portable exams in patient rooms, in order to reduce the physical stress of positioning the patient, especially while handling a heavy digital image receptor and when working with larger patients or patients who are not able to assist. Yet, two people working in a tight space may still have to adopt awkward (stressful) body postures in order to accomplish this physically stressful activity. Nurses and hospitalists noted that the lack of space was problematic when there were emergency codes. PCAs indicated that it could be difficult to obtain vital signs data in crowded rooms with limited access to the wall-mounted cuff to obtain blood pressures. Respiratory therapists and speech language pathologists indicated that the lack of space made it more difficult to perform their patient care procedures. Likewise, patient transporters noted challenges due to limited space on the far side of the bed when transferring patients. An interview with a construction worker indicated the need to frequently repair walls, doorways, and flooring on account of things being moved inside the room, indicating another hidden cost that comes with working in cramped spaces.

Table 2. Room design challenges for stakeholder groups when **doing** the stakeholder group's activities in the patient room.

Stakeholder group	Primary room design challenges when DOING primary activity
Hospitalist	▪ Whiteboard not accessible to hospitalist, patient and family. ▪ Need to have consistency of layout of components from room to room. ▪ Tray tables get caught on the bed, difficulty to move especially when cluttered. ▪ Difficult to move, raise and lower patient bed without disturbing other room components.
Nurse	▪ Few sterile work surfaces, crowded rooms, and equipment around beds make it difficult to do ordered activities ▪ Disturb patient to do care activities due to location of items ▪ Codes hard in small rooms and difficult when patient codes in a recliner or documentation nurse is in hallway.
Patient care assistant	▪ Crowded rooms and location of wall cuff makes it difficult to take vitals. ▪ Limited bed side access makes patient mobility and patient-handling difficult because patients might have to get up on their weak side. ▪ Inadequate bathroom design compromises provider and patient safety: small space (fall hazard), narrow door, step-up shower, toilet is too low, bumping into shelf, poor grab bar locations. ▪ Frequent request of patient/family members to reach inaccessible call lights, TV, and whiteboard.
Safety care associate (sitter)	▪ Difficult to keep patient in view due to room layout while interacting with/using television, call light, phone, computer, sink, and linen storage. ▪ Lack of task lighting or dimmer control when using computer without disturbing patient. ▪ No place to sit comfortably.
Case manager	▪ Positioning oneself to communicate intimately with a patient ▪ Lack of privacy in double room

Stakeholder group	Primary room design challenges when DOING primary activity
Physical therapy	▪ Inadequate room size. ▪ Difficult to clear path for helping patient ambulate: furniture, entangled cords, IV pole, tray table need to be moved. ▪ Difficult to move heavy recliner close to bed
Occupational therapy	▪ Difficult to maintain patient and provider safety in bathroom: toilet is too low, poor grab bar locations, sink doesn't accommodate seated patient. ▪ Difficult to clear path for helping patient to get to bathroom: furniture, entangled cords, IV pole, tray table need to be moved. ▪ Patient fall risk: outlets are too low and no space for shampoo in shower.
Respiratory therapist	▪ Limited space to provide breathing treatment therapies and a workspace to use their workstations-on-wheels (WOWs) and place their injectable drugs/aerosols. ▪ Respiratory monitoring could be completed from the hallway if viewing conditions permit.
Speech language pathologist (SLP)	▪ Need privacy to perform speech/swallow evaluation/therapy ▪ Limited access (SLPs and patient) to room components (whiteboard/clock) when performing speech/swallow evaluation/therapy ▪ Inadequate horizontal surfaces to perform patient care procedures and documentation with computer. ▪ Inadequate space and access to perform patient care procedures
Echocardiographer	▪ Inadequate space and access to perform patient care procedures on the correct side of patient for an echocardiographer. ▪ Interruptions of scanning procedure from other staff going into the room.
Sonographer	▪ Challenge of scanning backwards or in other awkward posture if unable get machine and tech in preferred position due to inadequate space.

Stakeholder group	Primary room design challenges when DOING primary activity
Vascular technician	▪ Limited space and access to perform patient care procedures on the patient's side. ▪ Interruptions of scanning procedure from other staff going into the room.
Radiographers	▪ Digital machine – receptor plate and/or patient can be too heavy for one person alone to handle, so 2 techs must fit into space near patient's bed to position receptor.
Dietitian	▪ When educating a patient, there is a privacy concern in a double room. ▪ Lack of space for a rounding team. ▪ Inconsistent access to computer in room.
Dietetic technicians	▪ Lack of privacy to discuss dietary issues with the patient. ▪ Positioning oneself in front of the patient so there is visual contact.
Nutrition aides (food service)	▪ Lack of clear surfaces on which to place a food tray when delivering meals reduces their efficiency and increases risk of spilling food on the patient.
Patient transporter	▪ There is inadequate space in the room when moving patients.
Housekeeper	▪ Difficult to reach and/or hard to clean room components include ledges, high shelves, picture frames, corners, cracks, crevices, light above patient bed, under the bed and sofa, etc. ▪ Hard surfaces and textiles in room can be damaged by chemical or bleach wipes.
Building operation	▪ Lack of uniformity in the rooms for location of boxes and valves. ▪ Some diffusers are right over the bed - making access difficult. ▪ Inadequate number and poor location of thermostats.
Clinical engineer	▪ Wiring and fixtures are sometimes difficult to access, often up high, and wiring is often mixed with IT cables. ▪ Lacking a flat surface on which to place their testing equipment. ▪ Need to avoid disturbing patients including minimizing noise when working.

Stakeholder group	Primary room design challenges when DOING primary activity
Mechanical shop (plumber)	▪ Need independent valves with shut-offs for each room. ▪ Inadequate access to plumbing (lack of access panels).
System shop	▪ Access to fix interface boxes for call lights and smoke alarms requires coordination with nursing staff to move a patient. ▪ Finding locations to mount TV's that work for everyone in the room.
Zone technician	▪ Cramped spaces make access difficult when working on toilets and sinks. ▪ Shut-offs not provided for every sink- need in every room. ▪ Lamps over patient bed are difficult to access, outlets are often located low on the wall and behind the bed.

The remaining stakeholder groups reported a variety of challenges while doing their primary function within patient rooms. The **lack of privacy in double rooms** was the most significant challenge for case managers, dietetic technicians, and dietitians who need to converse with patients about personal matters, including their health and living situations. **Access to selected items in the patient room** was considered a primary challenge during the "doing" phase for a few of the stakeholder groups. Dry erase white boards, used for communicating basic information to patients and families, that are difficult to see or access, pose a challenge to hospitalists who are seeking or updating information about the patient. Interface panels for nurse call controls that are located behind the patient bed and smoke detectors located on the ceiling are two room items that pose access challenges to systems shop personnel. Plumbers may encounter challenges posed by difficult to access plumbing lines. The lack of horizontal surfaces on which to place things was noted as the primary issue for the clinical engineers who need a place to set their test equipment. Likewise, nutrition aides need a place to set the food tray while they make room for it on the over-bed table. The building operations participants noted that while access to diffusers and control boxes in the ceiling was difficult, the lack of a standard location for the control boxes made their job particularly difficult because they must spend extra time opening multiple ceiling tiles to find the repair site. The mechanical shop plumbers are challenged by the lack of independent control valves in each room which makes it difficult to locate the water shut-off valves and when closed, they may be affecting multiple patients' rooms during the repair period. Housekeepers reported challenges to cleaning posed by very high and very low surfaces that were difficult to see and reach, areas that were difficult to reach because they were blocked by furniture or plumbing, and furniture with crevices that collected dirt and particles. **Bathroom**

design was a primary challenge to the work of the physical and occupational therapists. Problematic design features described by these groups included insufficient grab bars and low toilets. Both require stressful physical effort from staff when assisting patients getting on or off the toilet. The safety care associates (sitters) were challenged to keep the patient in view at all times, for example when the sitters are washing hands or using an in-room computer for charting.

Documentation functions were often performed in the room. Hospitalists, dietitians, and dietetic technicians all noted the lack of horizontal surfaces and/or dedicated workstations available for this component of their work.

Leaving the Room. When leaving the room, some stakeholders described the poor locations of sinks and trash receptacles, particularly in isolation rooms, where these items are sometimes located far from the doorway. This means that once the isolation PPE is removed and hands are washed, the stakeholder still needs to cross the room before exiting. Stakeholders that take equipment into the room are expected to wipe down the equipment before exiting, however, the inconsistent provision of cleaning wipes in the room means that these staff members have to find a way to store the wipes container on their equipment to ensure availability. As such, they would prefer that wipes were provided in all patient rooms. However, the plumbers do not like wipes to be provided in the room because they have found that wipes may also be used by patients or visitors who dispose of them in the toilet, which clogs as a result.

DISCUSSION

The results from this study show that there are many room design challenges affecting how work is performed in medical-surgical patient rooms. Most of these challenges occurred during the "entering", "preparing" or "doing" phases of work, although the various stakeholder groups reported different challenges across the four phases of the work process.

A number of the participants described themselves as "furniture movers" as they created a path for themselves and their equipment to access the bedside, or created a path to work with the patient in the room. In 2015, "furniture and fixtures" were identified as an injury source in four to 10 percent of lost time injuries reported by nurses, patient care assistants, and diagnostic medical sonographers (BLS, 2015, Table R11). Our participants repeatedly reported that space is limited in many hospital patient rooms. Having more space would address many of the issues in that it would make it easier to move the furniture out of the way, or eliminate the need to move it, and allow patients and family members to temporarily move out of the area surrounding the bed where most patient care activities are performed. One of the buildings at the medical center where this study was conducted has single patient rooms that are 30.7 m^2 (330 sq. feet). There were consistently positive comments about these rooms from all the stakeholder groups when pictures of rooms were shown during the focus groups and interviews. However, smaller rooms, where the layout is optimized, may be a more efficient

approach (Harper, Watkins, & Minnier, 2014) in that they are more cost-effective in terms of building costs, operational costs, and energy consumption. Current guidelines (Facility Guidelines Institute, 2014) state that clearances for the bed in medical-surgical rooms are "36 inches (0.91 m), 48 inches on the transfer side (1.22 m), and 36 inches (0.91 m) at the foot of the bed." Moreover, "In new construction, single patient rooms should be at least 12 feet (3.66 m) wide and 13 feet (3.96 m) deep exclusive of toilet rooms, closets, lockers, wardrobes, alcoves, or vestibules" (Facility Guidelines Institute, 2014).

When discussing the "prepare" stage of their work in patient rooms, seven of the stakeholder groups noted challenges associated with plugging in electrical equipment (e.g. computers, etc.) due to the lack of or poor access to the power outlets. Current guidelines state that there should be two power receptacles at each side of the head of each bed; two on each of the other walls (with the exception of the wall with the window), one for each television and one for the motorized bed (Facility Guidelines Institute, 2014). This is a significant increase from the guidelines published four years earlier, reflecting the increased demand from patients, their visitors, as well as the hospital staff. Locating power outlets higher up on the wall also makes accessing the outlets safer for staff and patients; bending over to reach an outlet near the floor is stressful on the back and can cause problems for a patient who may be unsteady, yet needs to unplug or plug in the IV pump when walking to or returning from the bathroom.

We did hear about inconsistencies that exist between patient rooms and how this becomes problematic for staff. The location of items such as light switches, personal protective equipment, hand cleaning materials and sinks, and the operation of remote control devices, window shades, and call lights, were issues that were reported by those who travel to many different rooms across different buildings in a medical center. Even though it may not specifically be part of a particular occupational stakeholder's "job" to operate lights, shades, etc., they are often asked by patients to adjust these settings as they are the people in the room at the time who could provide this assistance. Prior work with nursing staff has not identified these issues. This might be due to staffing patterns where nurses spend more of their time on a single unit than many of the other stakeholders in this study. Nevertheless, nurses are sometimes required to "float" to other units in response to uneven workload distributions, and thus would likely experience these challenges during those assignments. Light switches were particularly problematic, as most of the examples shown to the research team members were unlabeled, which in turn led to uncertainty regarding their function. While documents such as the Design Guide published by the U.S. Department of Veteran's Affairs (2011) suggest where switches should be placed, the document does not stress the need for labeling. Labels represent a feasible and low cost modification that should be applied to existing facilities in addition to new or remodeled facilities.

Concerns about the design of the bathrooms were expressed by patient care assistants and occupational therapists. Both groups noted that the restrictive bathroom space compromises both the patient and care provider safety. The certified nursing assistants and licensed practical nurses who participated in Sandford and Bosch's (2013) study strongly preferred having the toilet center be 30 inches from sidewall and having swing-away grab bars

located 18 inches on either side of the toilet as this allows bilateral access for a wheel chair or bilateral access for the care provider. This is considerably more space than the 17 to 19 inches between the toilet center and the side wall that is mandated by the Americans with Disabilities Act Accessibility Guidelines (Department of Justice, 2010). The three main factors identified by the PCAs and OTs in the current study, namely the height of the toilets, the poor grab bar locations, and sinks that do not accommodate sitting patients, are factors addressed by Fink et al. (2010) in their bathroom usability assessment tool for patient care facilities.

Limitations. A single institution was used in this study, and thus the findings may not generalize to other institutions. Nevertheless, there are multiple specialty care and satellite hospitals within the institution and thus a large variety of hospital room designs and sizes. In addition, nearly all of the study participants, with the exception of patient transporters, had previously worked at other hospitals, and they were instructed to incorporate their insights on challenges from their experiences at those institutions as well during focus groups and interviews.

Sample sizes were limited in some of the stakeholder groups, however, collectively many different points of view were heard. Focus groups and interviews were primarily done within stakeholder groups, and thus some conflicts across groups might not have been identified. Nevertheless, we felt that the stakeholder groups would be more free to represent their issues in single group sessions, particularly for those that have, historically, had less opportunity to provide their perspective on ways in which room design impedes their work productivity and/or imposes added physical stress as they perform their work. In the next phase of this research, we used mixed groups engaged in an active participatory design process to create the ideal medical-surgical hospital room. This process allowed for discussion and resolution of design conflicts that may appear between stakeholder groups.

In summary, this work has shown there are a number of issues that should be addressed in the next generation of hospital patient rooms or when refurbishing existing facilities. Given the trend towards single patient rooms, there is a need to determine the right size, layout, and content organization that allows all occupational stakeholder groups to work effectively, efficiently, and without undue physical stress while controlling building costs and providing a healing environment for patients and their visitors. This work also indicates that the full spectrum of occupational groups should be consulted during the hospital patient room design process, because each group has specific needs in these specialized work environments.

PHASE II: IDEAL ROOM DESIGN

Aim 2: Obtain consensus on the ergonomic challenges associated with patient room design and elicit stakeholder-specific recommendations regarding ergonomic aspects of patient room design.

This phase of the study was aimed at eliciting occupational stakeholder input on the room design parameters, including the room layout, types of furnishings, and the task-based design components that would allow them to more easily and effectively complete their work in Med/Surg patient rooms. The approach entailed small mixed occupational groups designing the ideal patient room in which they would like to work.

The single patient Med/Surg room being designed was a 300 square foot rectangular space (15 feet by 10 feet) that included a private bathroom. This design exercise was constrained by the size and shape of the space, the wall in which the door needed to be located (figure 4), the wall which would need to include the window(s), and that the bathroom needed to be included within the 300 sq. foot space and could not be located between adjacent rooms.

Once a room was designed, it was tested by bringing in selected pieces of equipment (e.g. patient transport cart, portable x-ray machine, etc.) and simulated patients (research team members) so that the effectiveness of the room layout and organization could be demonstrated.

Table 3. The occupational titles for the phase II participants

Occupational Stakeholder Group	n
Nurse	22
Patient Care Assistant (PCA)	14
Physician	11
Respiratory Therapist (RT)	6
Mechanical Shop	5
Physical Therapist (PT)	5
Social Worker	5
Diet Tech	4
Speech Language Pathologist (SLP)	4
Transporter	4
Dietitian	3
Echo Tech	3
Nutrition Aide	3
X-Ray Tech	3
Occupational Therapist (OT/OTA)	2
Sitter (Safety Care Associate (SCA))	2
Clinical Engineer	1
Interior Designer	1
Information Technology	1
Medical Student	1
Physician Assistant	1
System Shop	1
Unit Care Assistant (UCA)	1
Vascular Tech (VT)	1
Total	104

METHODOLOGY

Participants. During this second phase of the study, 27 participatory design workshops were held in which 104 individuals, representing 24 occupational stakeholder groups were recruited for the study (Table 3). In any given session, there was a heterogeneous mix of occupations, because each session's participants were selected based on individual availability.

Apparatus. Participants were asked to design a patient room in the 300 square-foot rectangular space. This 15 by 20 foot space was constrained as shown in figure 4 where the

doorway was along one of the two longer walls and the window took up part or all of the wall opposite the doorway (entry way) wall. At the beginning of the design exercise the contents of the room consisted of a patient bed, a sleeper sofa (on wheels), and moveable bathroom walls positioned randomly in the space. The remainder of the items in the room would be brought in by the researchers and positioned in the room by the participants. These bathroom walls and the room walls were covered with loop Velcro material which allowed any items that needed to be attached to a wall to be positioned by the participants (e.g. hand sanitizer dispenser, headwall displays, outlets, light switches, etc.). A list of all required and optional items that were used in this design exercise are listed in Table 4.

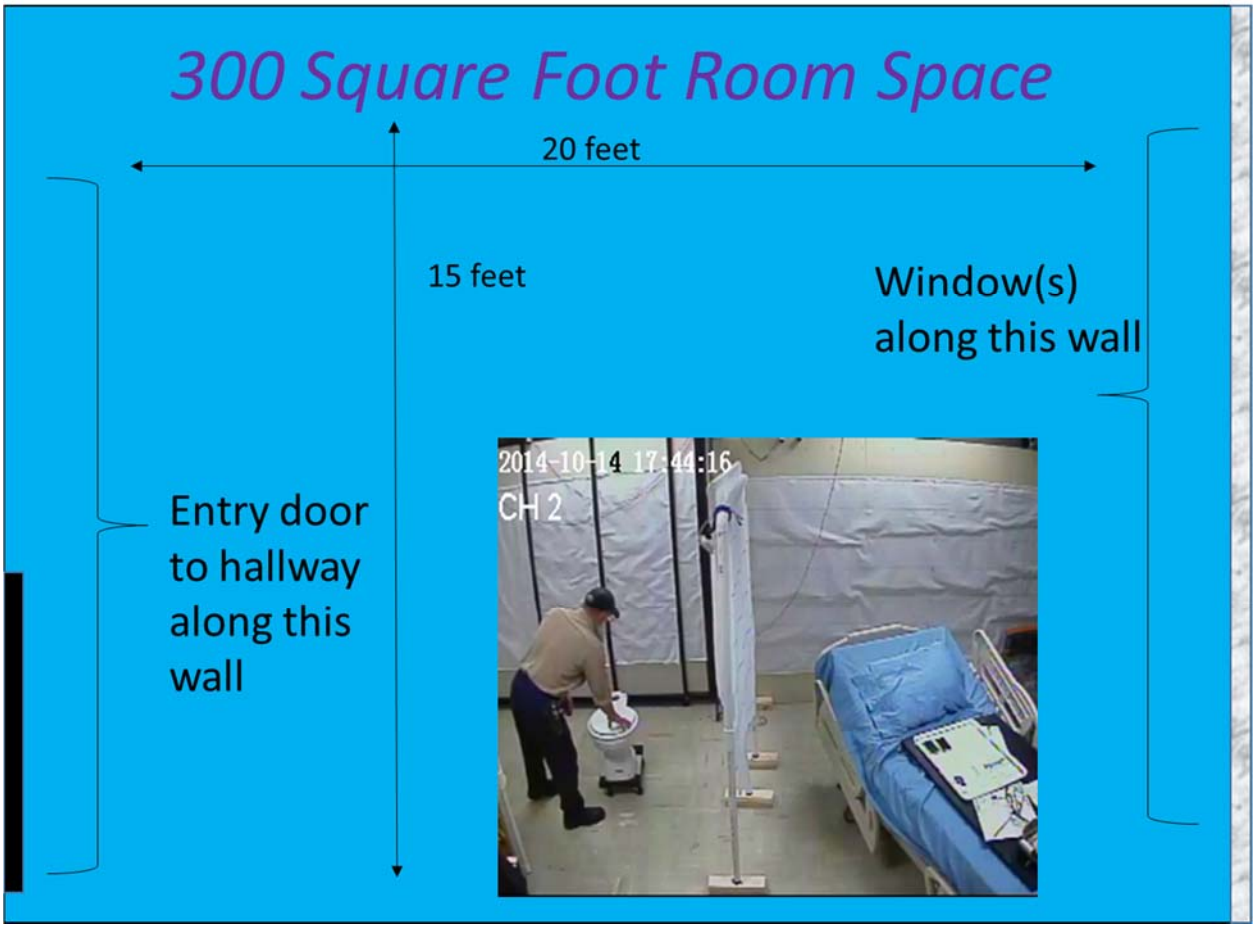


Figure 4. Full scale mock-up of patient room dimensions and constraints. Photograph shows moveable bathroom walls and a toilet being rolled into position.

Table 4. All required and optional items included in the full scale mock-up room layout.

Category 1: Items <u>required</u> to be in the room			
Bathroom:	☐ Bathroom Walls ☐ Toilet	☐ Bathroom Door ☐ Patient Sink	☐ Shower Area
Patient Room:	☐ Patient Bed ☐ Staff Sink ☐ Storage for Patient ☐ Patient Chair (recliner)	☐ Sofa ☐ Supply Storage ☐ Overbed table ☐ TV(s)/info / entertainment system	☐ Room Door ☐ Linen Storage ☐ Visitor chair(s) ☐ DVT – prevention pump
Utilities:	☐ Whiteboard/Info source ☐ Light Switches ☐ Telephone ☐ Headwall ☐ Physiologic monitor	☐ Code blue button ☐ Lighting over bed ☐ Wall clock ☐ Blood pressure unit ☐ TV control	☐ Electrical outlets ☐ Nurse call buttons ☐ IV Pole / IV Pump ☐ Room thermostat
Hygiene Items:	☐ Hand sanitizer ☐ Soap dispenser ☐ Soiled linen basket	☐ Glove dispenser ☐ Paper towel dispenser ☐ Sharps container	☐ PPE (gowns/masks) ☐ trash can ☐ Urinal bottle
Bathroom Items:	☐ Shower seat ☐ Handrails ☐ Bedpan	☐ Toilet paper dispenser ☐ Mirror ☐ Trash can	☐ Urine collection “hat” ☐ Soap Dispenser
Category 2: Patient items that must be accommodated during patient’s stay			
☐ Luggage ☐ Clothing ☐ Flowers	☐ Shoes ☐ Personal care items (lip balm, toothbrush, facial tissues) ☐ Health related items (eye glasses, dentures, hearing aids)	☐ Cell phone/charger ☐ Laptop/ Tablet PC /ipod & charger	☐ Entertainment materials (books, etc.) ☐ Greeting cards
Category 3: Optional items that may be included			
☐ Nightstand	☐ In-room computer workstation	☐ Wall hooks	☐ Shelves

☐ Artwork	☐ Small safe for patient items	☐ Foldable tray	☐ Privacy curtain(s)
☐ Ceiling lift	☐ Small table for visitors		
Category 4: Items brought in by occupational stakeholders that have to be temporarily accommodated			
☐ Meal tray	☐ Vitals monitoring unit	☐ Ultrasound machine	☐ X-ray machine
☐ Lift equipment	☐ Computer on wheels	☐ Step ladder	☐ Transport gurney
☐ Tablet computer			
Category 5: Items related to Patient's Condition			
☐ Walker	☐ Bedside commode	☐ Wheelchair	☐ Chair for sitter
☐ Respirator	☐ Dialysis machine	☐ Ventilator	☐ Chest tube box

Procedure. Participants first gathered in a meeting room. After signing the IRB approved informed consent document, the participants were presented with the goals of the design exercise. They then were presented with a white board that was used to represent the top view of a patient room and included moveable shapes representing the bed and sleeper sofa. They were asked to draw in where the bathroom should go and place the bed and sofa on the layout. After they discussed and placed these items, the participants were taken across the hall to the full size mock up room. The initial placement of the bathroom walls, bed, and sofa were put in place to be consistent with the whiteboard layout, however, these could be and frequently were changed by the participants once they were in the full-scale mock-up space. It should be noted that the sofa in the room did not have the length of the intended sleeper sofa that allows one person to sleep lengthwise. Participants were asked to leave space to accommodate a lengthier version or one that would become longer when needed.

Once these initial layout decisions were executed, the research staff brought in all of the category one and category two items in table 4. The participants placed all these items in the room. The optional category 3 items were introduced later. The participants would decide whether they should be included, and if so, where they would be placed. The resulting room layouts were then tested by having the investigators bring in items from categories 4 and 5 (in Table 4), if they were relevant to the participants of the specific session, so the participants could discuss and demonstrate how these items would be accommodated in the layout for different patient care task scenarios. At the completion of the design exercise participants were asked to provide a narrated tour of the patient room and describe to the investigators the features they've included and their rationale for doing so. This tour was audio and video

recorded. Photographs of the room, including each wall surface were taken to provide a photographic record of each item's placement. Once the participants left the session, the research team video recorded a "hot wash" where the key ideas that emerged from the just concluded session were discussed.

Data Analysis. Following the session the location and orientation of each item in the room was recorded using a three dimensional grid system. The room layout was then replicated in a top view using drawing tools in Powerpoint software. In addition, novel features of each design were noted by viewing the room photos, the video tour, and the investigator hot wash session.

At the completion of the 27 sessions, the 27 layouts were reviewed and clustered based upon bathroom location, bed location and orientation, and the location of the family area. This process resulted in five layout clusters that characterized the major differences in the room layouts. Within each cluster, the most representative and potentially most effective, and feasible design features were identified by the research team, and these were used to create a hybrid design representative for that cluster of designs. This analysis process resulted in the compilation of 5 five hybrid layouts, one representing each layout cluster.

RESULTS

Of the 27 layouts, 12 layouts were characterized as having the bed located adjacent to the inboard bathroom (Figure 5). A hybrid layout representing the key features from this cluster is shown in Figure 6. Key features of this hybrid room design were a sliding room door with a

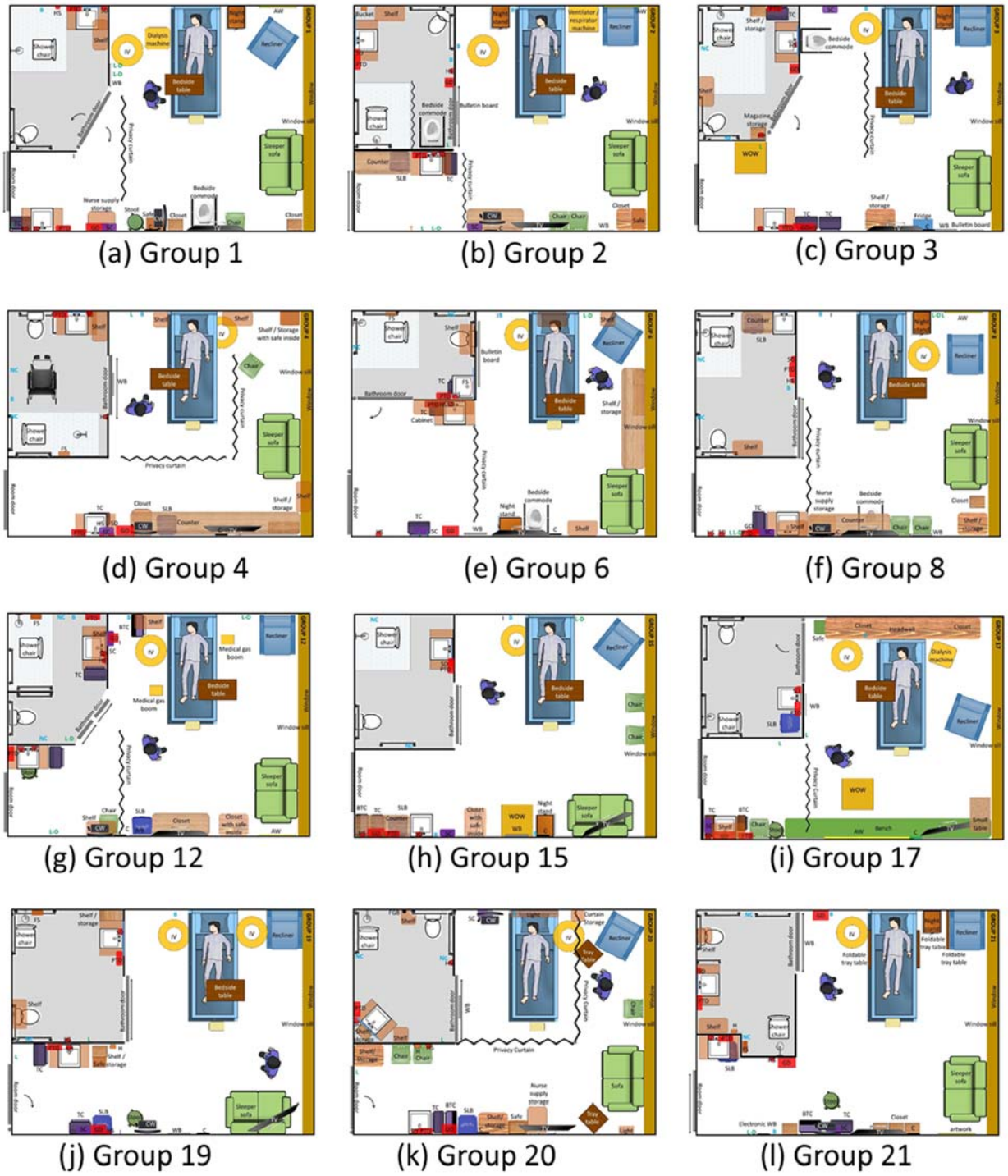


Figure 5. The 12 layouts characterized as having the bed located adjacent to the inboard bathroom.

secondary door that could be opened when more than 48 inches of access space is needed. The bathroom doorway was angled to facilitate staff seeing the patient from the doorway. There was a dedicated staff work surface near the patient bed and in the entryway. In the bathroom, the toilet and bathroom sink were placed along the corridor wall to facilitate plumbing access. The family area was placed along the window beyond the foot of the bed to ensure staff had access to both sides of the bed.

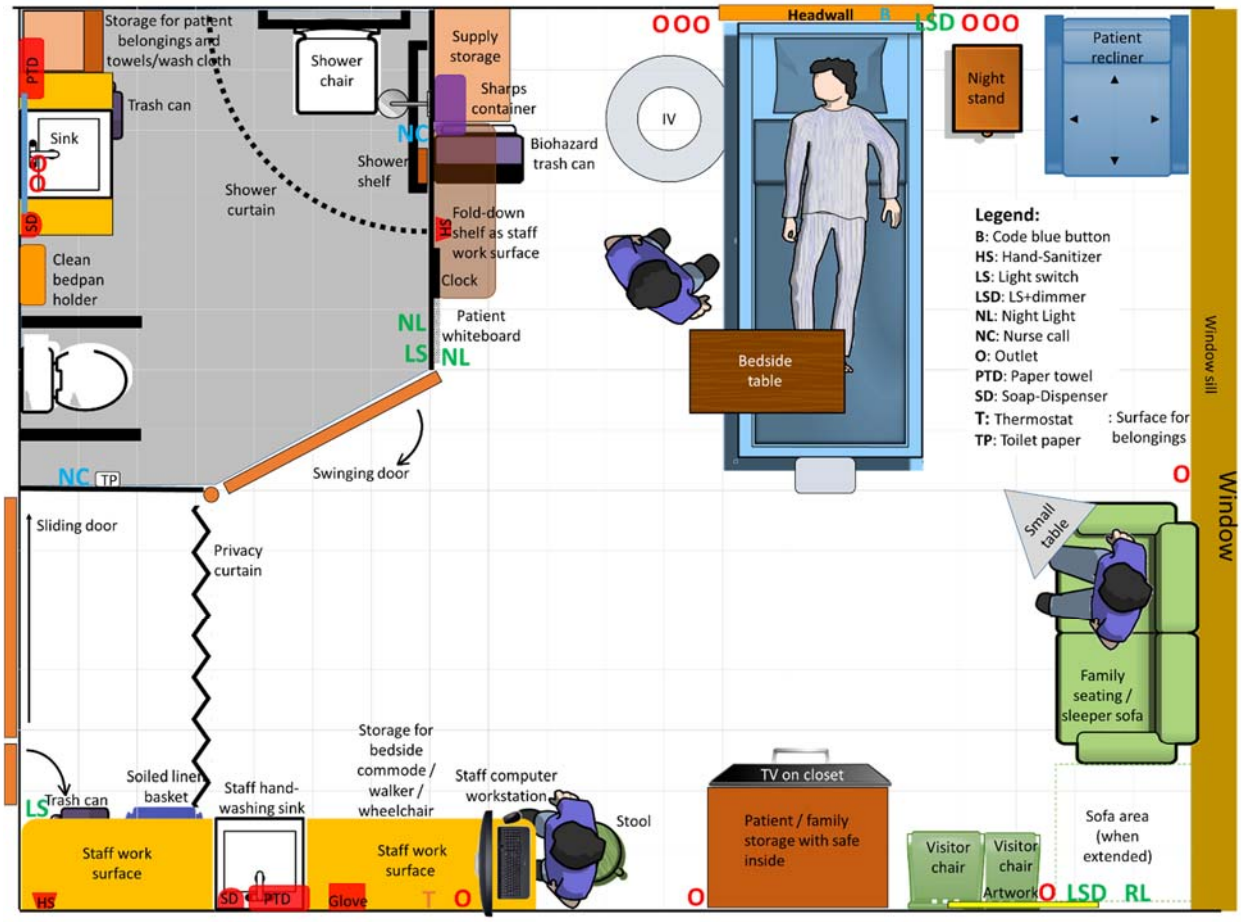


Figure 6. Hybrid room based on the 12 layout designs where the bed is located adjacent to the inboard bathroom.

The remaining 15 layout designs comprised 4 design clusters, with each cluster based upon 3 or 4 individual layouts. Figure 7 shows four rooms characterized as having a bed across from an inboard bathroom. The notable feature with these rooms is that the patient is clearly visible to staff from the corridor. Staff members indicated this was valuable for rounding and being able to determine if activities were going on in the room that should not be interrupted. Two of these rooms included French style bathroom doors that could swing either direction, therein allowing them to be pushed out of the way when the patient was either entering or leaving the bathroom. Two of the rooms had sliding bathroom doors. Figure 8 shows the

hybrid room created from these four layouts which included a sliding door configuration for the bathroom and entry doors. Even through the patient bed is in full view of the doorway, a privacy curtain can be used when desired by the staff or the patient.

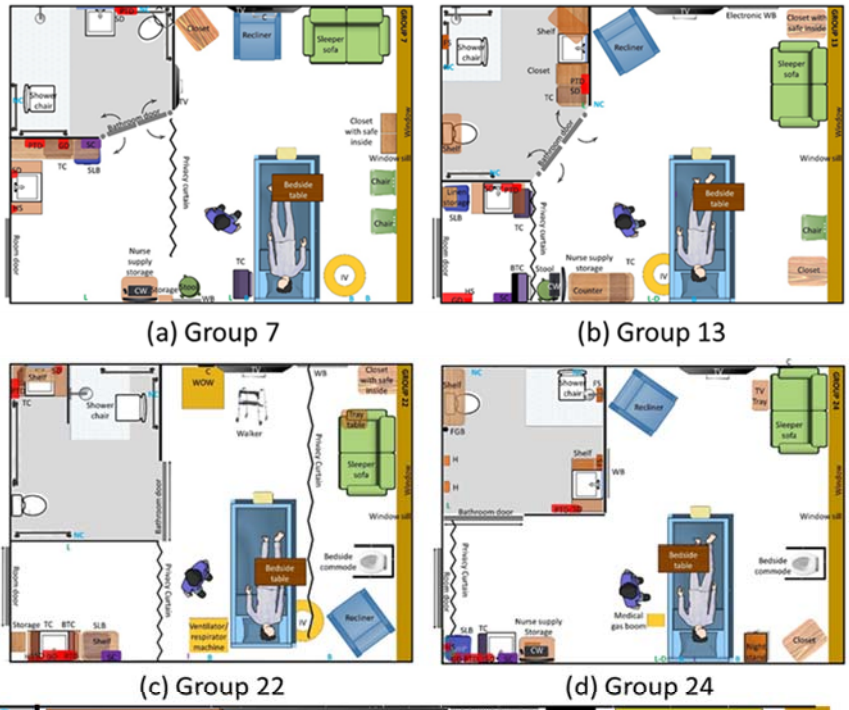


Figure 7. Four room layouts classified as bed across from an inboard bathroom.

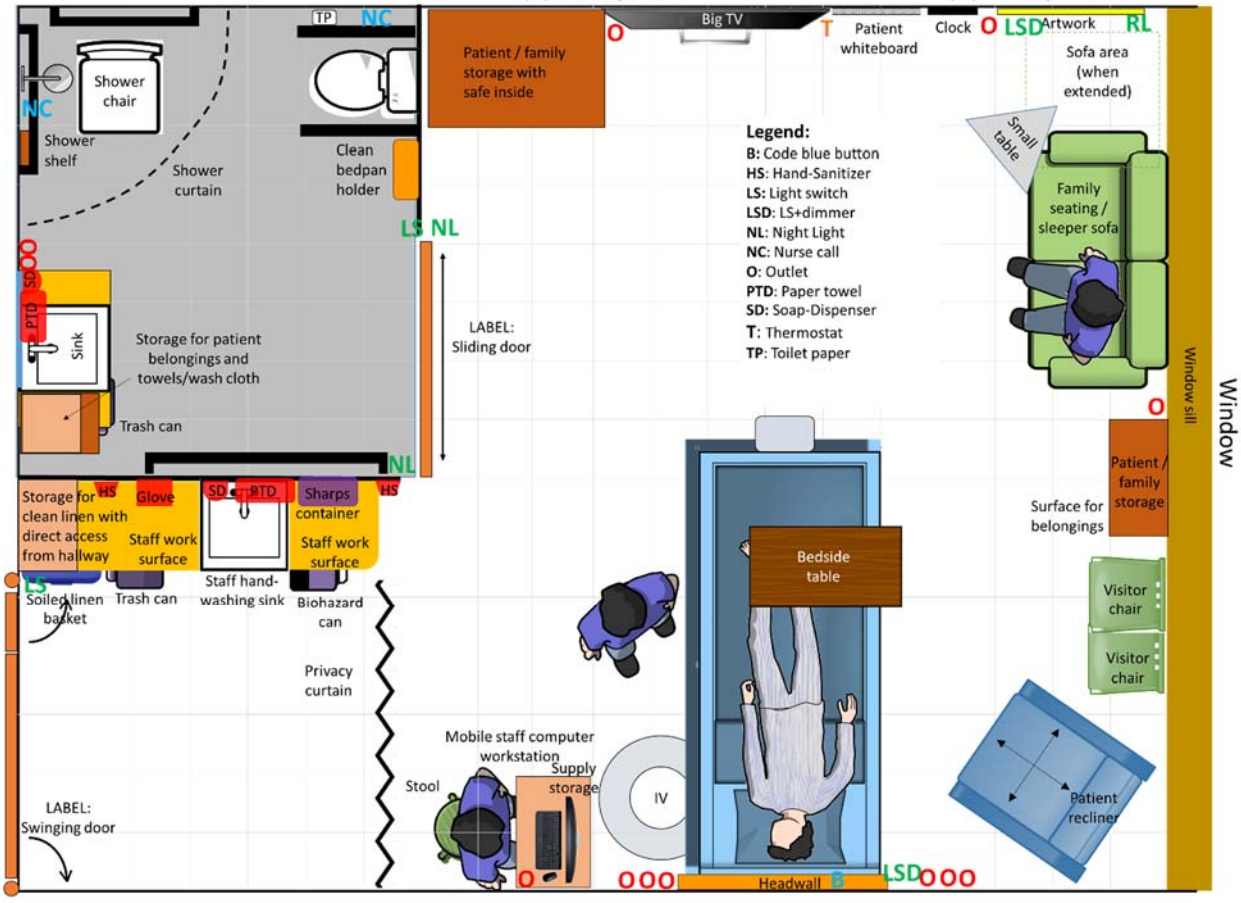


Figure 8. Hybrid layout based on the 4 layouts where the bed is located across from an inboard bathroom.

Figure 9 shows layouts where the participants designed rooms with an outboard bathroom across from the patient's bed and where the head of the bed was offset from the room door. The hybrid room in figure 10 includes a supply storage that can be restocked from outside the room, a large staff work surface along the corridor wall, a second privacy curtain to separate the family area when patient care activities are going on in the room, a sliding bathroom door, and a

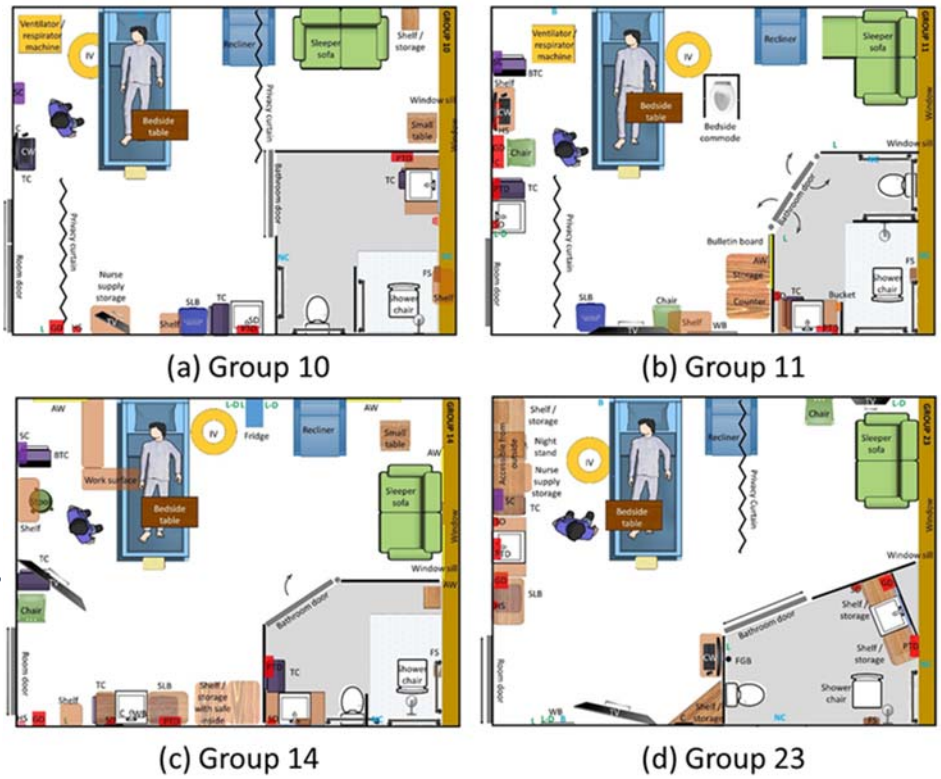


Figure 9. Room layouts where the bed was offset from the corner door with outboard bathroom.

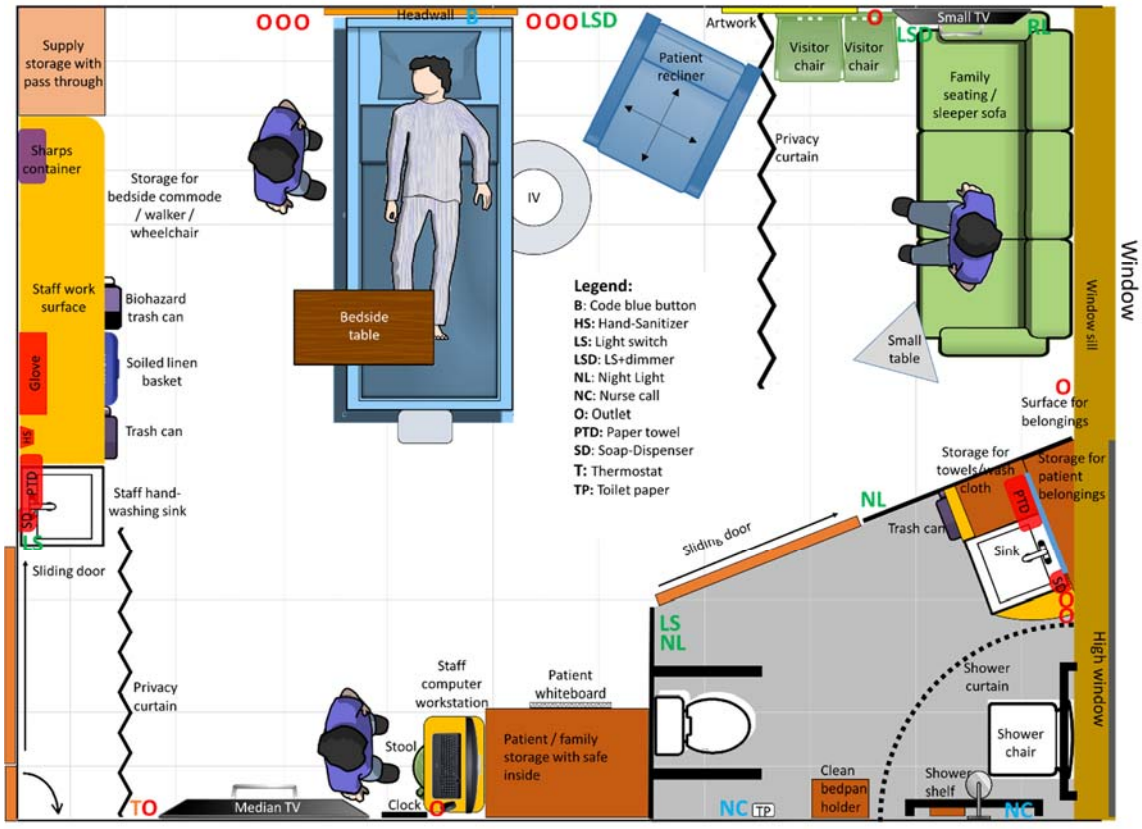


Figure 10. Hybrid layout where the bed is offset from corner door with outboard bathroom.

toilet oriented such that a minimal turn of the patient is required to seat the patient on the toilet.

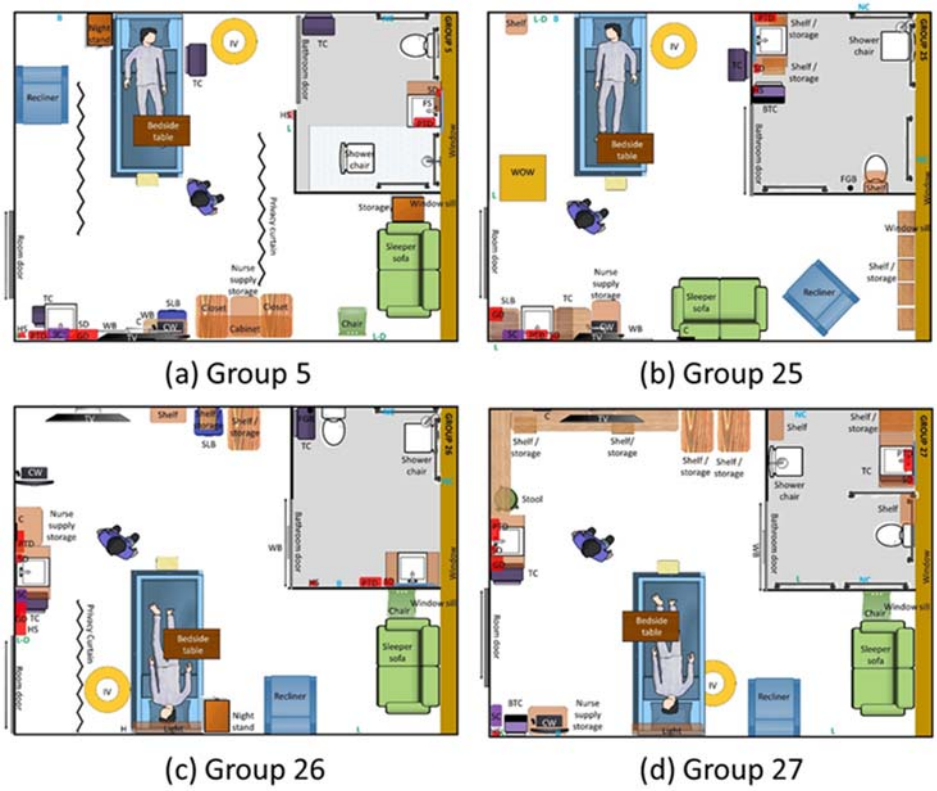


Figure 4. Individual room layouts with an outboard bathroom and a segregated family area.

Figure 11 shows the individual layouts and Figure 12 shows the hybrid design layout based on the rooms with an outboard bathroom and segregated family area. Some staff thought that having the family in their own defined portion of the room would eliminate potential space conflicts. This hybrid room had a large horizontal surface across from the bed that could be used by the staff, patients and family.

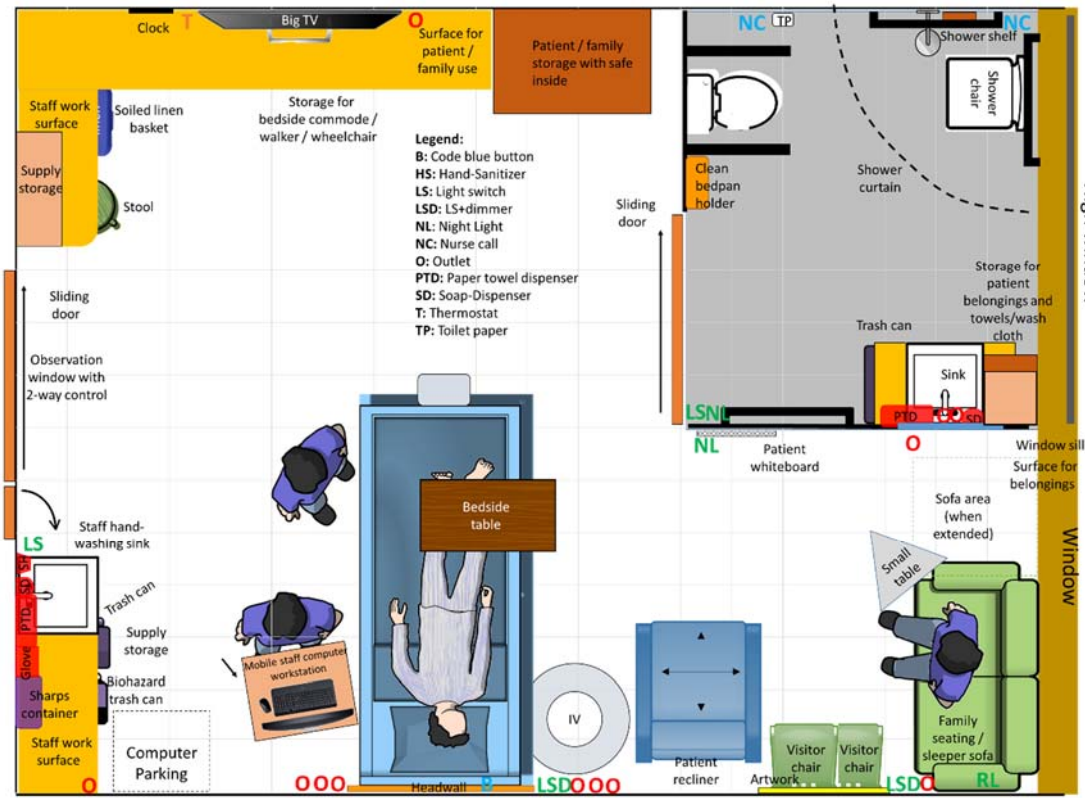


Figure 12. Hybrid design layout for an outboard bathroom with a segregated family area.

Figure 13 shows the three rooms where the bed was positioned at an angle relative to the rectangular shaped floor space. In all of these designs the bathroom was inboard. In two of the three designs the bed was oriented to facilitate the patient's view out the window. Figure 14 shows the hybrid version of these three spaces. In this room the bed is angled towards the window and is pulled out from what normally would be the headwall. This was by design as participants indicated a need to access the head of the bed during certain procedures.

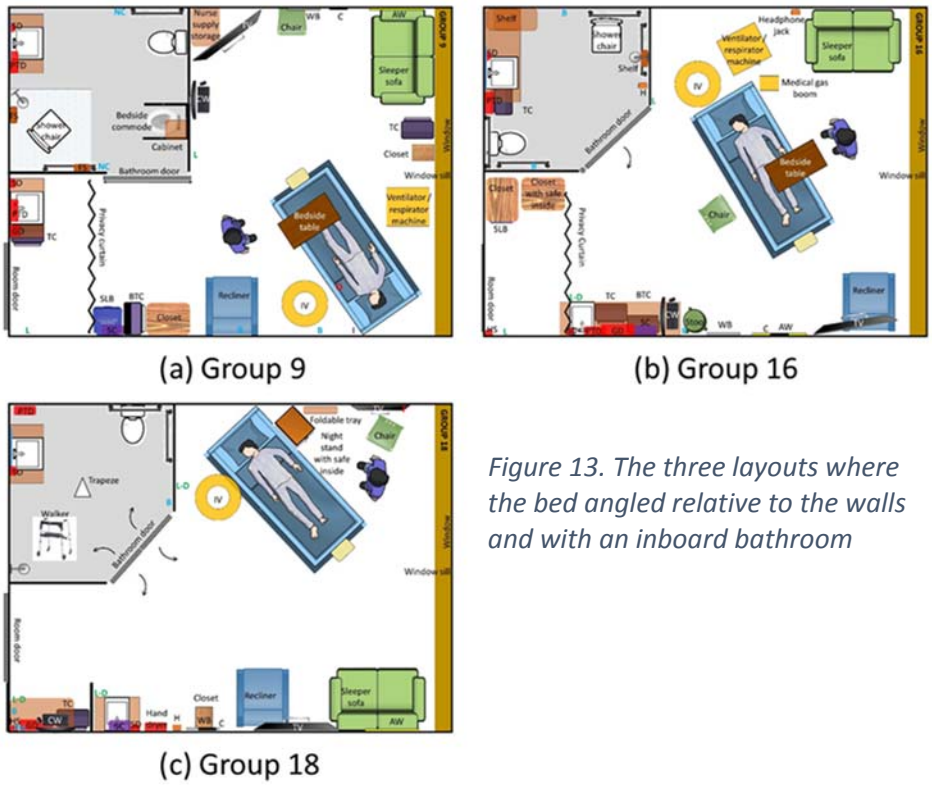


Figure 13. The three layouts where the bed angled relative to the walls and with an inboard bathroom

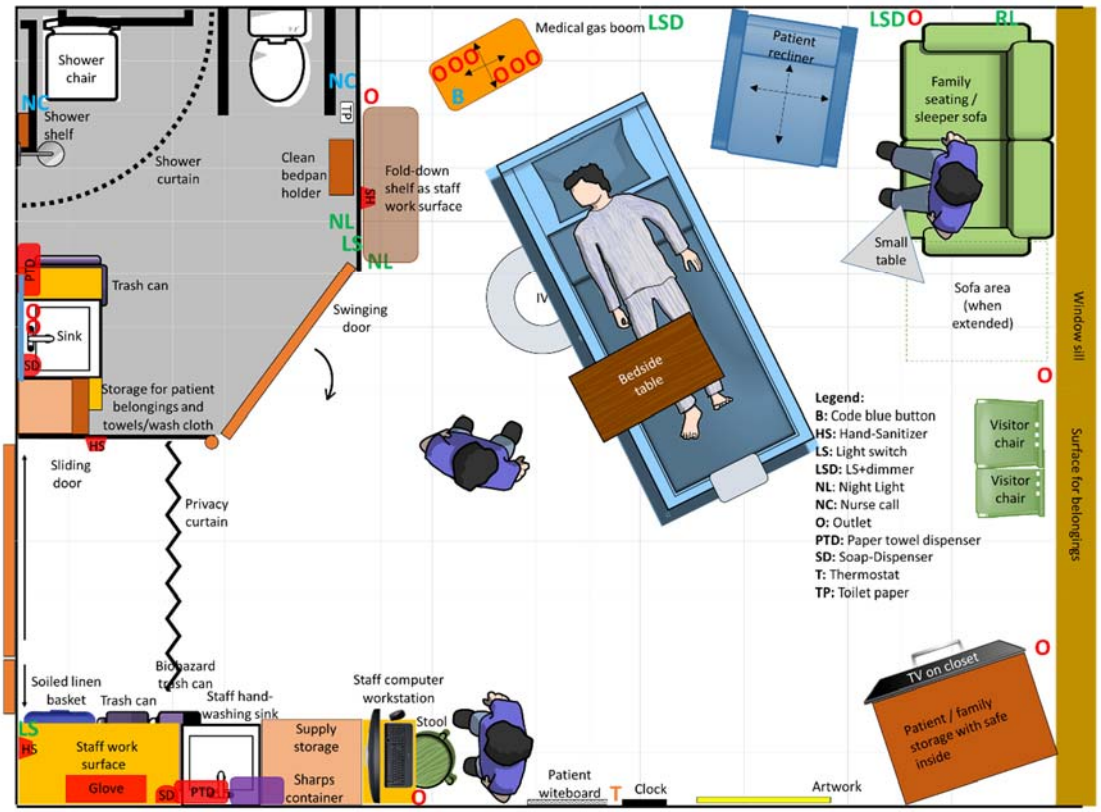


Figure 14. Hybrid layout for rooms with angled beds.

Several innovative features that address needs of staff and patients were expressed through the room designs. They are summarized in Figure 15. Many of these design features

Figure 15. Innovations identified across the room layouts developed in the second phase of the study.

allow staff to work more efficiently, but in many cases these features also reduce physical demands. For example, it is easier to assist patients on/off higher toilets, to have adequate horizontal surface space such that staff does not need to move patient or visitor belongings to set up and perform their tasks, having recliners designed with fold down sides to enable providing assistance with sitting or rising from the recliner. In addition, having recliners on wheels with brakes/release mechanisms on both sides, reduces reaching and awkward postures. Many other features reduce demands on nursing staff. These include standardized light switch placements and operations, giving the patient a remote control device that activates the window shades, lights, and room temperature and reduces the number of nurse call requests, therein allowing the nursing staff more time to complete clinical tasks and charting, providing the patient with accessible electrical outlets they can reach themselves, and having adequate storage for needed items on the tray table so that patients have easy access to them.

Further analysis of the bathroom layouts was performed, because many patient handling activities task place in this space. Moreover, patient falls have been associated with bathroom use in the literature. Approximately 11 percent of the patient falls in Krauss et al.'s (2007) retrospective study of nine hospitals were associated with bathroom use. Forty-six percent of the falls in Mandi et al.'s (2013) study of an orthopedic hospital were associated with bathroom use. In another study, also conducted at an orthopedic hospital, the percentage of falls associated with bathroom use was 64 percent (Ackerman et al., 2010). Therefore, as bathroom location could be a factor related to attempted bathroom use and patient falls, we conducted further investigation into the locations and characteristics of the bathrooms designed by the hospital staff participating in these participatory design sessions.

Of the 27 rooms designed through this participatory process, 19 had an inboard bathroom located just inside the room door and the remaining 8 had an outboard location near the window. The overall size of the bathroom ranged from 46 to 68 square feet (average=58.4 sq-ft).

Nurses preferred the bathroom close to the door so they could quickly and easily get in to assist patients when needed. Plumbers and housekeepers liked the bathroom close to the door so they would not disturb the patient when servicing the room. The doorway to the bathroom could be located on one of two walls or diagonally across the corner. A sliding door along the outside wall of the bathroom was chosen in 16 designs, and split ("French") doors were selected for five bathroom designs. Four designs had a conventional door that swung out and one had a door that could swing in either direction, and one swung in. The type of door affects how difficult it may be for patients with limited mobility, those being assisted by staff, or using mobility aids to enter the bathroom. For example when opening a conventional hinged door the patient may need to back up as the door is opened. This may not be true with a sliding door or French style doors that can swing both ways.

The distance from the center proximal edge of the bed to the bathroom door varied between 4.0 and 14.2 feet (mean = 6.6 feet). The stacked bar chart in Figure 16 shows the bed to bathroom door distance (mean = 6.6 feet, range 6.6 to 14.2 feet), the bathroom door to toilet distance (mean = 4.9 feet, range 3.4 to 6.0 feet), and the total distance from the center proximal edge of the bed to the toilet, which ranged between 9.7 and 20.2 feet (mean = 11.5 feet). Having a handrail along the wall between the bed and bathroom was only potentially feasible in 12 of the 26 rooms. But this would require that computers or other equipment were not parked so as to block access to the wall mounted handrail. Once inside the bathroom, it would be feasible to have a handrail along the wall between the toilet and door in many of the layouts developed by our participants. In some layouts the countertop with the sink, while not grasped as firmly as a handrail, could still help the patient retain stability. These distances and handrail availability also impact staff who are assisting patients to the toilet.

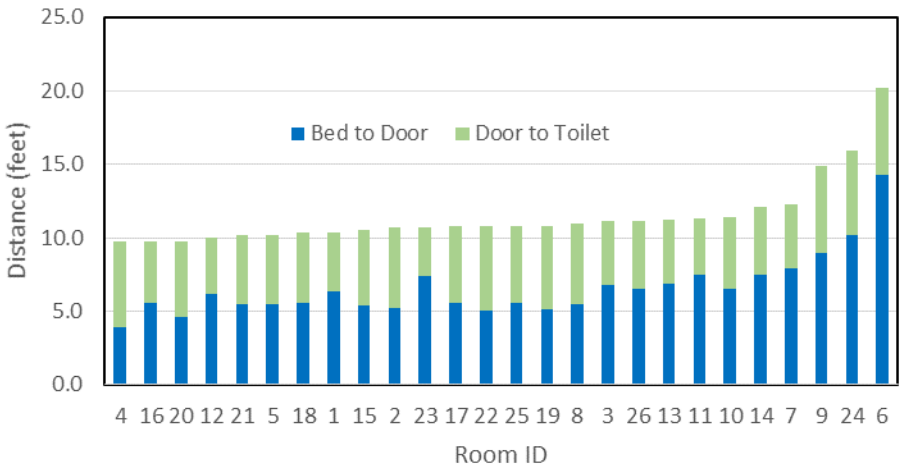


Figure 16. The total distance in feet between the bed and the toilet. The bar components show the distance from the bed to the bathroom door and from the bathroom door to the toilet.

In 10 of the bathroom layouts the patient would be able to see the toilet from the bed if the bathroom door was open. Twenty-two of the rooms only required one change in walking direction when ambulating from the proximal edge of the bed to the toilet. Three rooms required two directional changes and one room required three directional changes. These directional changes ranged between 10 and 100 degrees. As one walked into the bathroom, the toilet was located approximately along the path of travel (i.e., within 15 degrees) in 14 of the bathroom layouts. A 30 to 45 degree turn would be required in eight of the designs and a 50 to 90 degree turn would be required in 5 of the designs. Figure 17 shows that most

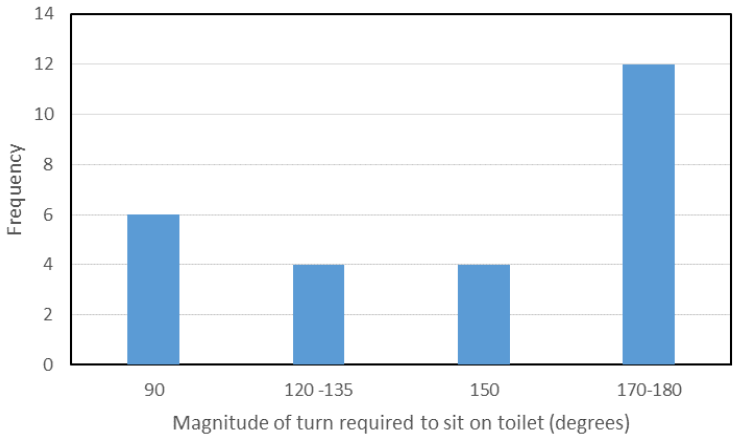


Figure 17. A frequency distribution of the turns required to sit on the toilet across the 26 bathroom layouts.

of the bathroom layouts would result in the patient having to turn 180 degrees to sit on the toilet. However, six of the layouts only required a 90 degree turn by the patient. Larger directional changes, whether along the path to the toilet or when sitting on the toilet, can be more destabilizing to patients, thus making it more difficult for staff to physically support these patients. This could lead to a patient fall, injury to staff, or both.

One major concern for patients is their privacy when in the bathroom, especially if they are not able to close the door. With the bathroom door open, the toilet was in view of the family zone in 10 of the layouts. It was visible from the hallway door in four of the layouts. In three of the hybrid rooms the toilet cannot be viewed from the family room (Figures 8, 10, and 14). Only one of the hybrid rooms potentially does not fully conceal the toilet from the hallway (Fig. 12),

PHASE III: PATIENTS AND VISITOR NEEDS

Aim 3: Identify patient room design parameters that impact the needs of patients and their visitors and family members, and elicit alterations in patient room design parameters that best support those needs.

In order to develop hospital patient room designs that, to the greatest extent possible, provide a supportive environment for hospital-based treatments and healing, it is important to understand the unique perspectives of patients and caregivers. In this part of the report, we present the findings from a set of room concept evaluation sessions in which patients and family caregivers evaluated two rooms from the set of five hybrid room designs concepts developed in Phase II. All five hybrid room designs were evaluated by multiple groups of patients and family caregivers, but time constraints limited each group to viewing only two of the room designs. The overall goal of this phase was to investigate what makes a desirable and supportive healing environment for patients and families.

Supportive room design is believed to reduce patient stress and increase coping, ultimately improving the healing process. Based on a review of 214 publications, evidence was found for beneficial effects from well-designed acoustic environments, ventilation and air conditioning systems, the thermal environment, lighting, views of nature, ergonomic conditions and furniture (Salonen, Lahtinen, Lappalainen et al., 2013). In one study, Keep, James, and Inman (1980) compared the response of patients, in rooms with and without windows, located in intensive therapy units. Those with windows more accurately remembered their admission and discharge, were more oriented during their stay, and had fewer sleep disturbances, hallucinations, and delusions. Devlin and Arneill (2003) identified that patient control had an important role in patient outcomes, including control over the sound, light, and art in patient rooms. Some design guidelines already exist that could support meeting patients' needs and expectations. Ulrich (1991, 2000, 2004) offered guidelines for architects to incorporate into their design, including fostering the occupants' sense of control over the physical surroundings,

promoting social support, and providing access to daylight and other positive distractions such as pleasant music, artwork, and fountains. Lindheim (1985) argued that social connectedness, self-esteem, meaning, and control are all characteristics that can help an environment accommodate a range of needs for all types of individuals.

METHODS

Participants. Participants who evaluated the room concepts were patients and family caregivers who met the inclusion criteria of the patient having a minimum 3-day stay in the hospital in a medical-surgical unit in the last 12 months. The 15 evaluation sessions included 61 participants (37 patients, 24 family caregivers), of which 20 were males and 41 were females. One participant was under 30 years old, 12 were 30-45 years old, and 48 were over 45 years of age. Fifty participants were white, seven were African American, and four did not indicate a racial category.

Procedures. Approval for the study was obtained from our Institutional Review Board (IRB). Upon arrival, all participants reviewed and signed an informed consent document and completed a demographics form. The moderator then reviewed the purpose of the study, the agenda for the session, and asked the participants to complete a survey using a 5-level response scale (not, slightly, moderately, quite, or very important) on the relative importance of 12 general design characteristics of medical-surgical patient rooms, such as "The staff sink can be seen by patient lying in bed." The survey was based upon design characteristics identified in prior phases of this research. Once the survey was completed, the moderator introduced the participants to a top-view layout diagram of the first of the two rooms they would evaluate. The order of the two room design concepts viewed by the groups of participants was sequential (e.g., Room 1 to Room 2, Room 2 to Room 3, etc.). The participants were then taken into the full size simulated room (the same Velcro-walled space and contents used in Phase 2 of this study). The moderator provided a guided tour that explained the furnishings and other items in the space, and any unique features of that room design concept. The participants were given the opportunity to ask questions and interact with the room. While in the room they were then asked to complete a survey to evaluate the room design based on 17 room elements and features, including physical layout of the room (e.g. "Location of the bed relative to the hallway door", "Amount of seating for family & visitors"), visual privacy (e.g. "Visual privacy available for the patient"), and "Your overall impression of this room". Five response choices ranged from "Strongly Dislike" to "Strongly Like". The participants then returned to the conference room where the moderator engaged the group in a discussion by asking 'What did you like best about the room?' and then 'What did you dislike most about the room?' This process was then repeated for the second room design concept. The entire session was audio-recorded and the recordings were professionally transcribed.

Data analysis. For survey questions, response frequency counts and median values are reported. Grounded theory analysis of the verbal protocols was conducted using a Straussian approach (Strauss & Corbin, 1998). The first level of data analysis was to complete line by line coding of transcripts from interview sessions with former patients. This procedure of axial coding gave way to the development of initial parent and child codes in a large codebook. It was through this process that the team was able to look for structure by collectively sharing and confirming the output. The codebook was iteratively and collaboratively expanded by having two independent coders analyze the same transcript and share their parent and child codes. The team reviewed all codes and came to consensus on existing and missing codes. This demonstrated our team's interplay between researcher and the data (Strauss & Corbin, 1998).

Researchers used the formative code book to analyze the transcripts from the patient and caregiver room evaluation sessions. Subsequently, all printed transcripts were coded and all memos generated by investigators were shared and discussed to confirm and continue building a solid base for further analysis. When insufficient information was provided to select a specific child code, the parent code was used. Moving forward, the codes were clustered into groups based upon memos and representative quotes. This process is formally known as conceptual ordering, which helps to form an overarching explanatory scheme (Strauss & Corbin, 1998). As the analysis grew, the ordered clusters were reviewed using a comparative analysis technique. The analytic clustering was inductively mapped onto hospital room areas generated by the team of investigators: Entry Zone (13 codes), Clinical (and Patient Bed) Zone (25 codes), From Bed to Bathroom (3 codes), Bathroom (15 codes), Storage (6 codes), Information (6 codes), and Tray/Overbed Table (4 codes).

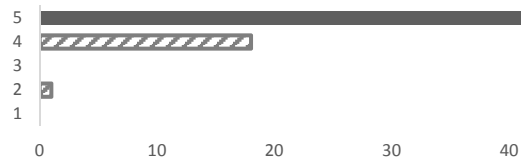
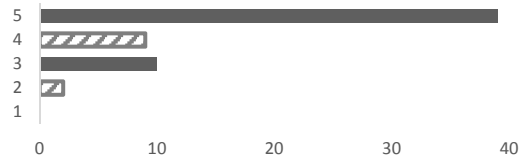
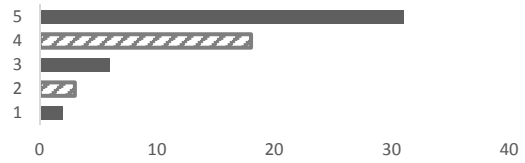
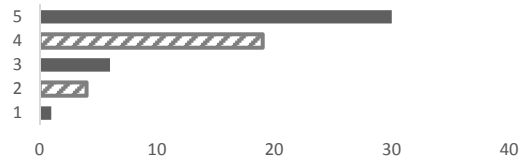
As further analysis developed, the team was able to determine relationships. This act of constructing relationships between the clusters of codes associated with room area categories facilitated the team's ability to begin theorizing about what matters most to patients in a hospital room (Strauss & Corbin, 1998). The research team analyzed and discussed the identified parent and child codes in the room concept evaluation session transcripts, in order to synthesize the numerous codes and categories of codes into a smaller number of major categories of patients' needs and expectations. These major categories were organized by corresponding room zone and preliminary themes were allowed to emerge at this stage. These emerging themes were identified for each emerging cluster grouped by room area and subsequently visually displayed in a theoretical design framework.

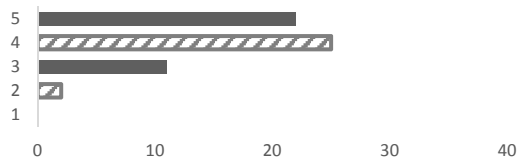
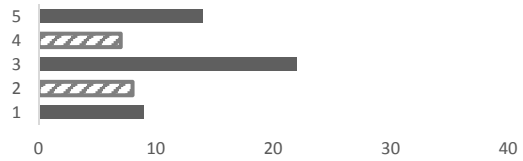
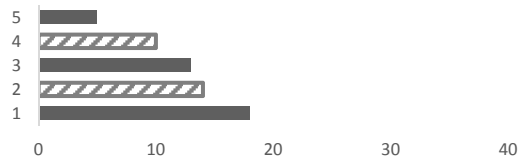
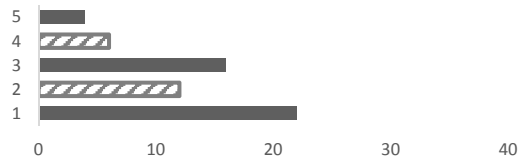
RESULTS

The findings from the room feature importance survey are displayed in Table 5. The responses with the highest medians, those rated as most important, involved providing access to room controls (lighting, entertainment center), providing visual privacy, and being able to read the whiteboard from the patient bed. Responses that were rated to be the least

important were visibility of the staff sink from the patient bed and having the bathroom door located near the hallway door. The response rate was 98.4% based on 60/61 participants. One participant did not fill out the survey due to a late arrival to the evaluation session. Four participants each did not fill out one individual question about the patient handling (lifting) device, with two participants noting "don't know" and "NA" [not applicable] above the missing response.

Table 5. Patient and family caregiver participant members' ratings of the importance of 12 general features of a hospital room.

Survey Question	Category (Responses)	Median
1. There is easy access to room controls (lighting, television), for the patient and family.		5
2. The room, by design or by other means such as curtains, provides visual privacy for the patient.		5
3. The whiteboard/ communication board is located so that the patient can read it while lying in bed.		5
4. The distance from the bed to the bathroom.		4.5
5. A ceiling-mounted patient handling (lifting) device is available for the patient who requires assistance to move in and out of bed.		4
6. The whiteboard/ communication board is located such that it is easy for the patient and family to write notes or questions on it.		4

7. While in bed, the patient can see people as they enter the room.		4
8. Hospital staff can sit at a patient's eye level when speaking with a patient		4
9. When the nurse, doctor, or other caregiver is using the computer, they are facing the patient		3
10. While in bed, the patient can see into the hallway if the door is open		3
11. The staff sink can be seen by patient lying in bed		2
12. The bathroom door is located near the hallway door		2

1 = Not important; 2 = Slightly important; 3 = Moderately important; 4 = Quite important; 5 = Very important

The median scores from the evaluations of the five hybrid rooms based on the 17 room elements and features survey showed that the patients and visitors were generally positive about all of the rooms. The median scores were primarily "Like", across the 17 elements and features. For two of the features that mattered most, based on the "importance" survey, which were the location of the whiteboard and the visual privacy for the patient, Room 3's median score was "neutral" for both, while the median scores for the other rooms were all "like". "Distance from the bed to the bathroom" was also rated high on importance, and on the room evaluation survey, Room 2's median score was "Strongly Like", while the median scores for the other rooms were still positive ("Like").

The emerging findings from the grounded analysis of the patient room evaluation sessions are displayed in Table 6. The "Patient Needs/Expectations" column represents a summary of all the parent/child codes (in contrast to the top ten codes that are shown in Table 3). Many of the most frequent codes related to supporting the patient in independently accessing room elements (e.g., bathroom, tray table, outlets, whiteboard) from the head of the patient bed. Similarly, the view from the patient bed, specifically visibility of the hallway and exterior space via the window, was found to be important. The leftmost columns in Table 6 show how each expectation is categorized by the area of the patient room as well as the particular aspect of that area. The "Rationale" column describes why the needs and expectations are important to the patients. The emerging themes are shown in the right-most column. For the entry zone, the design element focusing on visibility and noise stemmed from the patients' desire to have a sense of control over the entryway to the room. When in bed, patients want to be in a position to readily see who is entering the room, as this provides a sense of safety and security. Related to this need is a desire to avoid being disturbed by noise and activity from the hallway. There were mixed responses on this issue. Some study participants liked being able to view activity in the hallway to reduce boredom, but even in this situation, they wanted to have control over whether the room door was open or closed, even when a privacy curtain was used to block the entry way. Survey responses to item 10 in Table 5 ("While in bed, the patient can see into the hallway if the door is open") confirmed the mixed perceptions on this issue, with nearly as many participants rating this statement as not important or slightly important as compared to quite important or very important. Even in situations where patients could control whether a room door was open or closed, they expressed a desire to have a privacy curtain, particularly for when clinical procedures were performed in the room, in order to be shielded from view of anyone passing by in the hallway or entering the room while the procedure was underway. As supporting evidence, 80% of participants rated the following statement as quite important or very important: "The room, by design or by other means such as curtains, provides visual privacy for the patient" (#2, Table 5).

Table 6. Emerging Findings from Transcript Analysis Regarding Patients' Expectations, Rationale, and Emerging Themes Grouped by Room Zone.

Room Zone	**Patients' Needs/Expectations**	**Rationale**	**Emerging Themes**
Patient room *in total*	A single patient room that is adequately sized, comfortable, and comforting for patient and visitors	Promotes patient movement; supports visits by family and other visitors	Comfort for patient Comfort for visitors

Table 6. Emerging Findings from Transcript Analysis Regarding Patients' Expectations, Rationale, and Emerging Themes Grouped by Room Zone.

Room Zone	Patients' Needs/Expectations	Rationale	Emerging Themes
	A room that accommodates patient's physical limitations	Benefits include: • a room that is more comfortable for the patient; • patient can experience a higher level of control and independence	Accommodation Comfort Accessibility
Entry zone	An entry way design that: • Affords control over visual privacy and hallway noise • Enables patient to see who is entering the room	• Patients desire visual privacy. • They want to be able to control the level of the noise for rest and for stimulation. • The entry way needs to provide a sense of safety/security.	Visual access Visual privacy Noise control Rest Stimulation Sense of security
Clinical zone	• Desire to have private conversations with clinical staff when needed • Buffer to separate patient from staff as desired • Recognize and observe authorized staff in room	Supports a range of interactions that occur between patients and staff, from the most serious, personal conversations to just acknowledging an authorized staff member is in the room to perform tasks that do not involve the patient.	Privacy Personal space Personal safety
Patient zone	A room design that: • Affords control over visual privacy • Enables patient to see: o who is entering the room o staff hand hygiene practices o outside the room (window, hallway)	Controls visual access (to see and be seen)	Visual access Visual privacy
	Easy access to: • Power: many accessible electrical outlets • Current information (staff, labs) • Entertainment • Means to easily control the room environment (lighting, temperature) and other electronic room components	• Accessible outlets support keeping cell phone at hand, which supports communication and connection. • Patients want to know who is taking care of them today; who should be in the room. • Easy to use, multi-function remote control supports comfort, control, and independence of patient.	Sense of security Information Communication Entertainment and stimulation Control Independence Connection to outside
	Desire to be in an uplifting environment that is conducive to rest/sleep	Promotes healing	Patient can rest Patient can sleep Patient can heal Comfort

Table 6. Emerging Findings from Transcript Analysis Regarding Patients' Expectations, Rationale, and Emerging Themes Grouped by Room Zone.

Room Zone	Patients' Needs/Expectations	Rationale	Emerging Themes
	Organized places to put things that patient can reach without assistance	Empowerment and self-sufficiency	Patient can reach his/her things Access Independence
	Visible and secure patient storage within reach or view: • A place to display items (cards, photos, flowers, etc.) • A clean place for personal items	Enables peace of mind and inspiration	Patient can see his/her things Belongings are safe Connection to home
Hygiene Zone (patient bathroom)	• A close bathroom that is easy to access, even with IV pole, wheelchair, walker, etc. • Safe toilet access day and night • Barrier-free shower access • Privacy in the bathroom	Easily accessible bathroom can somewhat offset mobility impairments of patient; supports safety, independence, and control	Easier, safer access to bathroom Privacy Access

Converging on a Theoretical Design Framework for What Matters to Patients in the Hospital Room Experience

Using a process of comparison of the grounded analysis of the patient and family caregiver room concept evaluation sessions together with the survey data results allowed for building confirming and disconfirming evidence. Quotes were retained and tabulated as part of this process to continue moving to the construction of a proposed theory about what matters to patients in the hospital room experience. It was through this constant comparative method of triangulating the higher level grounded data that we are able to propose the following grounded theory of what really matters to patients in an ideal hospital room: Patients expect a hospital room that provides them with the comfort needed to support healing and with the perception of connection to the outside world. The hospital room should provide them with quick and independent access to their belongings and offer increasing levels of control throughout the course of their hospital stay. The theory is embodied in a theoretical design framework that is visualized in Figure 18. The ideal patient room experience unfolds over time

as the patient transitions from a state of dependence to a state of independence as the patient heals and prepares to go home.

The framework highlights the center of the ideal hospital room experience which is the patient's need for comfort. Comfort is central in the sense that it is the most important need. It is also the need that stays sharply in focus throughout the entire hospital room experience. The secondary needs (i.e., connect, access and control) vary in importance according to the unique situation of each patient. Patients need to connect to others such as family members and friends. The need for connection expands over time to include connections to the outside world

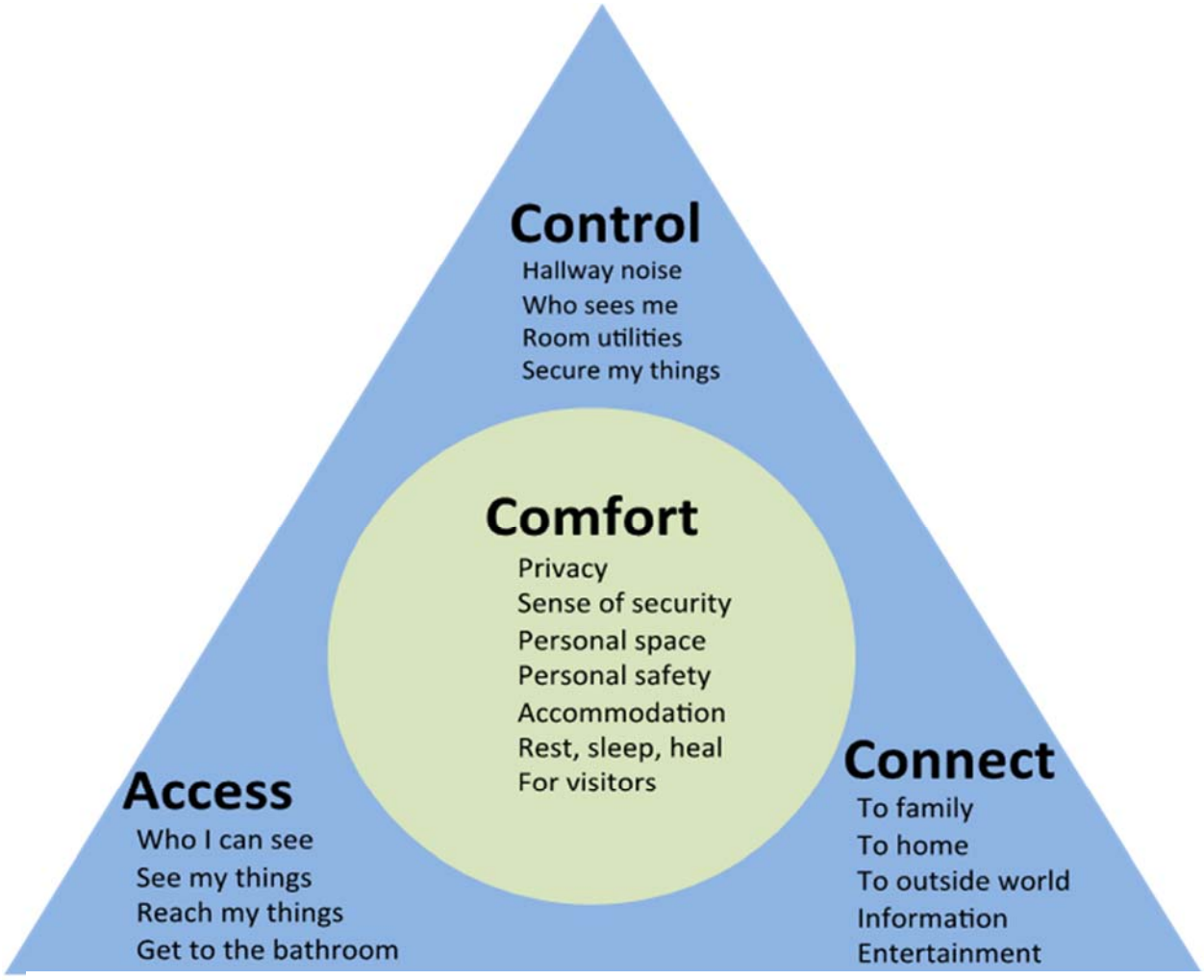


Figure 18. Theoretical design framework for the patient room experience (Patterson et al., 2017).

such as connections to home, to nature and to what is going in the world. As the patient heals, the need for access becomes more evident. Access includes visual access (Can the patient: See who is entering the room? See the flowers that their loved ones have given them?) and physical access (Can the patient: Reach their phone? Charge their laptop? Get to the bathroom safely?). The need for control becomes stronger throughout the patient journey as well. Patients want to be able to control the room environment components such as the

temperature, lights, window coverings, etc. as well as the television. They want to control the security of their belongings. Patients would also like control over the noise and visual access from the hallway outside their room (Can the patient: Obtain a quieter environment, including having less noise from the hallway? Prevent strangers from looking into the room and seeing them in bed?). The relevance of the needs outside of the comfort core will vary according to factors such as: How sick is the patient? How long is the hospital stay? Are family and friends visiting often? How much does the patient rely on a communication technology device to stay connected?

Based on what we learned during Phase 3, some changes were made to the hybrid rooms, such as relocation or inclusion of additional whiteboards that would be more visible to patients and their family members.

PHASE IV: DESIGN VALIDATION AND CONFLICT RESOLUTION

Aim 4: *Resolve conflicts between stakeholder groups with regard to patient room design parameters, thereby, allowing for a clear set of design parameter recommendations for patient rooms.*

Table 7. Occupational stakeholder groups participating in the room review session.

Stakeholder / Group	n
Case manager	1
Diet tech	3
Imaging	8
MD	5
Housekeeper	12
Iinterior designer	1
Nurse	6
Nutrition aide	1
OT / PT	6
Patient care assistant (PCA)	10
Respiratory therapist (RT)	5
Sitter (safety care associate (SCA))	4
Social worker	4
Speech language pathologist (SLP)	3
Transporter	6
Total	75

Approach. Occupational stakeholders were invited to evaluate the 5 hybrid room designs, with each session typically reviewing three of the five rooms. Fourteen room review sessions were conducted which resulted in each room being viewed by 7 to 9 groups of participants. These small group sessions began in a conference room with a review of the top view diagram of the room (figure 19). This overview was followed by a tour of the full-scale mock-up space of the first room prototype. Participants were given a set of surveys to rate the room and its features while they were in the room. After each room was toured, the group returned to the conference room and discussed what they liked and disliked about each room design for approximately 15 minutes. While this discussion was going on, the mock-up space was reconfigured to the next room on the list. This process of room introduction, room tour, survey, and post tour discussion was repeated until the 90 minutes allocated for the session had elapsed. Conflicts over the space and room features were also discussed to identify trade-offs and, where possible, to achieve resolution. The discussion of conflicts was conducted near

the end of the session. Then at the conclusion of the session, participants were asked to identify the rooms that they favored most and least.

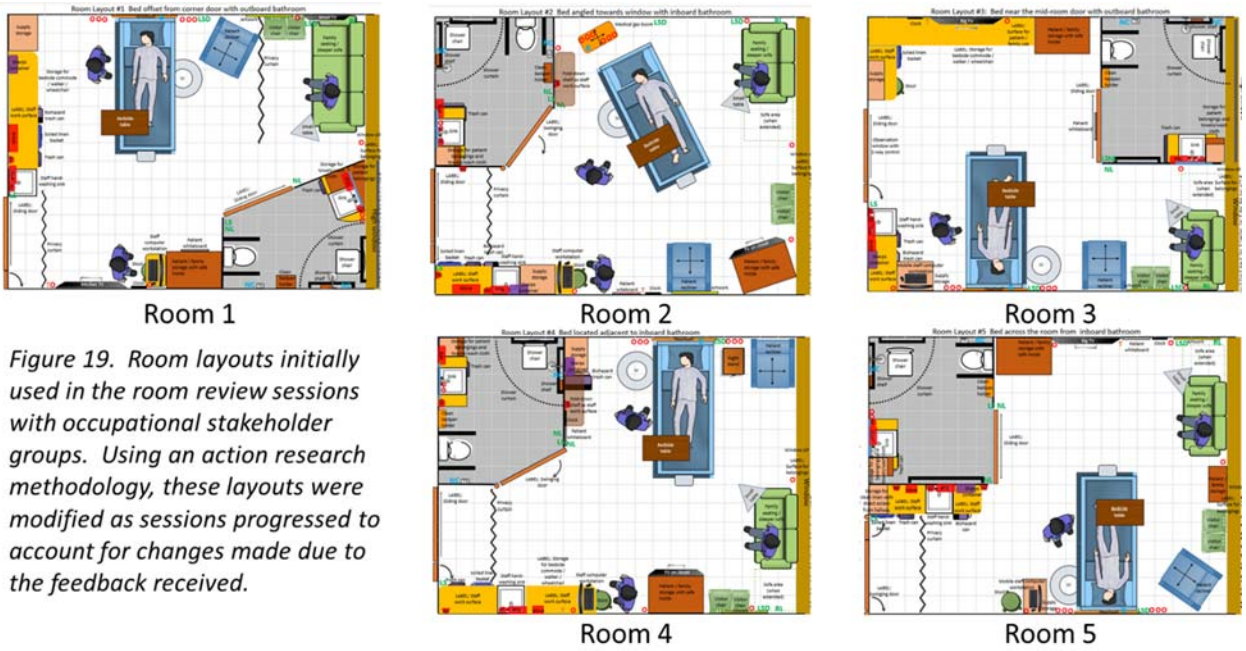


Figure 19. Room layouts initially used in the room review sessions with occupational stakeholder groups. Using an action research methodology, these layouts were modified as sessions progressed to account for changes made due to the feedback received.

This research used an action research approach wherein feedback received on these rooms was considered at weekly research team meetings and room layouts were updated where the research team considered it to be appropriate. This judgement was based on views of prior occupational participants, as well as the views that had been previously expressed by the patients and visitors.

RESULTS

Survey data were tabulated and averaged for all stakeholders. Figure 20 shows the overall averages across stakeholder groups for each hybrid room layout. While the scale on the survey instrument went from “strongly dislike” to “strongly like”, the scale on the figure starts at “dislike” as no average values were in the “strongly dislike” range. Overall, the staff liked room layouts 1 and 5 the best and room layout 2 the least (question 14). Large differences across the rooms (mean difference > 1.0) were noted for item 5) location of the bathroom door, item 8) location of the storage supplies, item 10) questions related to work surfaces, item 11) location of the whiteboard, and item 12) family and visitor area.

A deeper look into the comments made during the discussion revealed some key conflicts and concerns which are summarized in Table 8. There are a number of design elements that result in conflicts between staff, conflicts between patients and staff, and conflicts between staff and visitors.

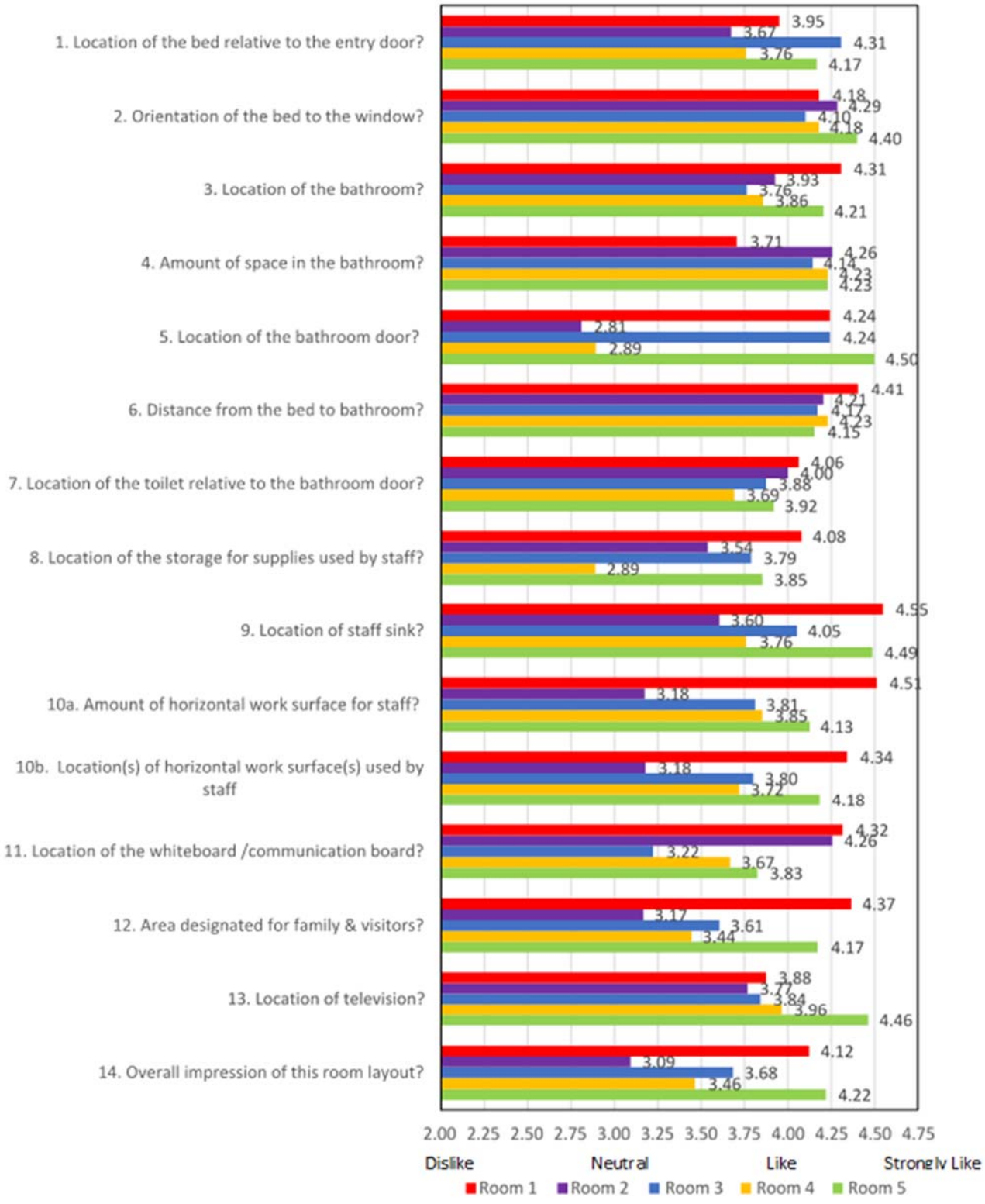


Figure 20. Survey response averaged across all participants for each room layout.

Table 8. The key issues for designers to consider as a result of the Phase 4 room review sessions where conflicts were discussed.

Conflict	Pain Points - Key Issues to Consider
Bathroom Door Style	Swinging doors pose problems: they reduce usable space within the room and are more difficult for patients with mobility limitations. Sliding doors are preferred, although can present hygiene and acoustic issues.
Bathroom Size	Size of bathroom must accommodate wheelchair turning with caregiver, large patients, and two caregivers providing assistance with toileting; more space is needed to assist larger patients. However staff who do not work with patients in the bathroom want to trade a smaller bathroom for more space in the patient room.
Bed Location	Putting the head of the bed near the room door facilitates staff's visual check on patients, but creates conflict with patients who have privacy concerns and concerns about noise from the hallway.
Bed Orientation	Angling the bed towards the window makes it easier for the patient to see out the window but may create other constraints on the room space that impact staff, depending upon the overall shape of the room.
Space Around the Bed	Staff and equipment (e.g. portable x-ray machine, portable ultrasound machine) need sufficient access space on both sides of the bed and different members of staff require more access to different sides of the patient in bed. At the same time, patients want to be within reach of their belongings.
Computer Style/Location	Staff want to use the computer in the room without having their back to the patient; , it should be able to be positioned for use without the power cord creating a trip hazard. If a dedicated mobile computer ('computer on wheels') is in the room, it should have a dedicated parking area where it will be out of the way when not in use.
Control Over Room Temperature	Patients want to be able to control the room temperature without imposing on staff; staff do not want the room to be too warm for them to work or too warm for the health of the patient.
Entry to the Room	Many things need to be near the room door so that staff can work efficiently and safety while disruptions to the patient are minimized. For example, PPE needs to be near the room door, as does the dirty linen container, the hazardous waste

	container, and the staff sink. The entry way has to be large enough for gurneys and accompanying staff to move through with ease.
Entry Door	Swinging doors are easier to install than sliding doors, but swinging doors reduce effective space within the room. Glass doors promote patient visibility yet compromise patient privacy.
Family Area	Space for family that is near and visible to the patient is important, however, if it extends into clinical space it can interfere with staff's ability to work, including patient care tasks. Staff also expressed concerns that having the family area too large invites too many visitors, which can also interfere with work and the need for patients to rest.
Horizontal Work Surfaces	Horizontal surfaces in the patient room are needed by staff but are often cluttered with patient and visitor belongings. Dedicated surfaces for both staff and patients are needed. Staff work surfaces need to be proximal to the bedside as well as in the entry, and clearly identified as being for staff use.
Nightstand	While the nightstand has traditionally been a place for the room phone and flowers, it is often inaccessible to the patient and in the way of staff working at the bedside. Yet, if eliminated this reduces the patient's horizontal surface and storage areas proximal to the bed.
Electrical outlets	Never enough outlets–staff, patients, families/visitors all compete for outlets; especially in demand are outlets near the bed. Patients and family members may bring multiple devices that need electricity or need to be charged
Privacy Curtains	Not having a privacy curtain between the bed and the family area results in awkward situations (e.g. family being able to observe a procedure performed on patient in some level of undress) or the need to remove family from the room during certain activities. The latter could pose a problem for a family member with mobility limitations.
Recliner Location	Locating the recliner such that the patient can easily transfer between bed and recliner with assistance from staff, interact with family, see the TV, and easily access the bathroom while at the same time not being in in the way of staff working in the room.
Sharps Container Location	Clinical staff want the sharps container close to the bedside, whereas housekeeping staff want it close to the entry door so it can be emptied with minimal disturbance of the patient.

Shower Design	Keeping water within the shower area while also minimizing the lip of the shower (a trip hazard) for patients during shower ingress and egress.
Staff Sink Location	Staff sink should be close to the entry door, however, some patients want to be able to observe staff hand washing.
Storage for Patients/Visitors	Adequate storage takes up space in the room, but needs to be provided so patient and visitor belongings do not interfere with staff activities in the room. Patients want secure storage for their valuables, however staff is concerned about other things that may be stored in these spaces. Patients want some storage they can reach from the bed and other storage they can see from the bed.
Supply/Linen Storage	Staff wants storage to be in one dedicated area. If located on the corridor wall, they would like a pass-through set up so supplies can be restocked without disturbing the patient. Epidemiology/hygiene may not allow pass-through.
Television Location	Television needs to be located so it is visible to the patient and visitors, but out of the way of staff (no head bumping).
Toilet Location	Toilet location within the bathroom should afford the patient privacy from the corridor and the family area, while also being easy for the patient to access, and allowing more than one staff person space to assist the patient.
Whiteboard	The whiteboard needs to be sized and located such that it can be easily read and easily updated by staff, easily viewed by the patient and family members.
Window	The window needs to be visible to the patient while lying in bed; staff also want the patient to be able to see the entry way to the room so they do not startle patients as they approach the bedside.
2-way window in door (or corridor wall)	This feature puts staff who want to be able to easily check in on patients without disturbing in conflict with patients who have privacy concerns.

GUIDELINE DEVELOPMENT PROCESS

Based on the data acquired through the prior four phases of the study, the research team formulated 66 guidelines that should be used as they design new or remodeled med/surg patient rooms. The distribution of the guidelines across the different areas within the patient are shown in figure 21. For each guideline presented in tables 9-13, the tables list the key room items related to each guideline, the constraints that need to be considered when implementing each guideline, and the rationale for each guideline from both the staff and patient perspectives.

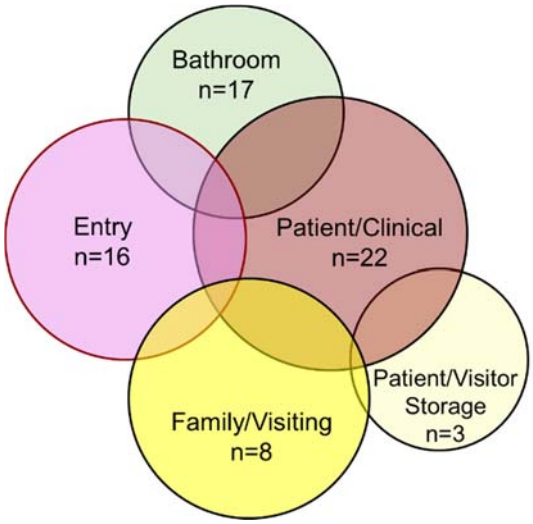


Figure 21. The number of guidelines (n) created for the different areas of the med/surg patient room.

These guidelines were presented at the 2017 Healthcare Design conference to an audience that was largely comprised of architects and interior designers. The audience at this presentation was asked to participate in an IRB approved survey process. Specifically, the audience was asked to rate along a five point scale if each guideline would be "easy to do" or "hard to do" (scale endpoints). They were also asked if they "already do this". If this was out of their job classification, then that could also be indicated on the survey. The percentages of respondents who indicated the guideline would be easy to implement (marked one of the two highest ratings on the 5 point scale) and those indicating that they are already implementing the guideline are also shown in tables 9-13. The reader will quickly recognize that implementing individual guidelines may be relatively easy, however, implementing all of the guidelines makes the design process more challenging as multiple dimensions may need to be considered for each design decision. Nevertheless, each guideline is based on the data that indicates it of value to one or more stakeholder group.

Table 9. Patient Room Entryway Guidelines							
Primary Item	Secondary Item	Design Guideline	Design Constraints	Why (Staff)	Why (Patient)	Easy to Do (%)	Already Do (%)
Room Door	Room Door	1. Use an easily operated manual sliding (barn style) door rather than a swing or folding door* (*There is conflict regarding whether the door should be opaque. Staff want to see patient vs. some patients want visual privacy.)	· Door needs to accommodate signage. · Door needs to effectively limit noise transmission to or from the hallway. · Smoke tight	· Less space is taken in the room. · Removes the need to back away from the door when opening. · Easier for staff to use. · Removes door knob/handle that catches on beds, IV's, etc.	· Easier for patients to use. · Removes door knob/handle that can be bumped into or catch IV line.	44%	20%
Room Door	Patient's Bed	2. Position room door so that staff can see patient's head from entry way.	· Position the bed such that patient's head is not too close to the doorway.	· Efficient staff rounding balanced with patient privacy and security. · Staff do not want to startle patients when entering the room.	· Patients want the ability to see when people are entering the room. · Patients do not want to be startled when people come in the room. · Patients want to see who is entering the room. · Patients want to have their privacy and control corridor noise. · Patients do not want to feel like they are on display.	46%	39%
Staff Sink	Room Door	3. Staff sink should be inside the room, near the door.		· Facilitaes staff hand washing upon room entry and exit. · C.difficle precautions require hand washing rather than use of hand sanitizer.	· Viewing staff washing hands is important to some patients and visitors.	83%	57%

Table 9. Patient Room Entryway Guidelines							
Primary Item	Secondary Item	Design Guideline	Design Constraints	Why (Staff)	Why (Patient)	Easy to Do (%)	Already Do (%)
Biohazard Container	Room Door	4. Space should be allocated for a biohazard container near the room door.	· Dedicated space has to be large enough to accommodate containers holding isolation apparel and procedural materials. · Container cannot obstruct the entry way.	· Staff needs to dispose of personal protective equipment (PPE) as they exit the room. · Cleaners wants to be able to empty waste without disturbing the patient. · Staff brining equipment in/out of the room do not want obstructions in the path of travel.	· Patients do not want to be disturbed when waste is removed from the room.	61%	48%
Non-Biohazard Trash Can	Room Door	5. Space should be allocated for a trash can near the room door.	· Dedicated space has to be large enough to accommodate trash bins used by the facility. · Trash can placement cannot obstruct the entry way.	· Cleaners wants to be able to empty trash without disturbing the patient.	· Patients do not want to be disturbed when trash is emptied. · Patients don't want to smell or see the trash.	68%	44%
Vital Signs Monitor	Room Door	6. Vital signs data can be viewed from room doorway	· Vital signs monitor should be positioned at a location so that staff working in the room do not bump their heads on the monitor.	· Efficient staff rounding, less disruptions for patient.		33%	19%

Table 9. Patient Room Entryway Guidelines							
Primary Item	Secondary Item	Design Guideline	Design Constraints	Why (Staff)	Why (Patient)	Easy to Do (%)	Already Do (%)
Lighting Controls	Room Door	7. Provide clearly labeled lighting controls just inside room entrance.	· Separate switches for different spaces within the room. · Mapping of switches should match the room layout. · Consistent switch layout in all patient rooms.	· Reduce staff confusion. · Reduce patient disruptions.	· Patients and their visitors want to be able to determine which light switch should be used.	89%	31%
Horizontal Surface in Entryway	Room Door	8. Provide a horizontal surface intended for staff proximal to the room entry door.	· There needs to be separation from the staff sink to keep surface dry. · The surface cannot reduce effective width of the entryway space. · The space should be sufficient for a laptop computer or tablet that is visible from the clinical zone.	· Provides staff a place to set things as they enter the room.		46%	39%
In-Room Medical Supply Storage – Permanent Option	Room Door	9. Locate permanent storage near room door or along corridor wall with a pass through design.		· Facilitates restocking with minimal disturbance to patient or other activities going on in the room.	· Restocking can occur without disturbing the patient.	30%	15%

Table 9. Patient Room Entryway Guidelines							
Primary Item	Secondary Item	Design Guideline	Design Constraints	Why (Staff)	Why (Patient)	Easy to Do (%)	Already Do (%)
In-Room Medical Supply Storage - Mobile Option	Room Door	10. Provide adequate space for in-room mobile medical supply storage with a horizontal work surface that can be used by staff.	· Needs to be able to get close to the bed. · Needs to have a parking spot for the storage unit that is accessible to users and doesn't impede workflow.	· Gets supplies close to where they are needed. · Allows staff to work more efficiently. · Work surface allows staff to work more effectively.		33%	17%
Linen Supply	Room Door	11. Locate linen supply near room door or in the room along the corridor wall with pass through design.	· The pass through may not be permitted by hospital policy.	· Facilitates restocking with minimal disturbance to patient or other activities going on in the room. · Reduces the need to don and discard PPE when restocking.	· Restocking can occur with minimal disturbance to patient.	17%	17%
Hand Sanitizer	Room Door	12. Locate hand sanitizer near room door and in view of the patient.	· Place inside the room. · Must meet Life Safety Code requirements for alcohol based hand rub dispensers (NFPA101-2000).	· Facilitates use of hand sanitizer upon room entry/exit.	· Allows patients to see that their caregivers are following procedures that prevent infections.	90%	54%

Table 9. Patient Room Entryway Guidelines							
Primary Item	Secondary Item	Design Guideline	Design Constraints	Why (Staff)	Why (Patient)	Easy to Do (%)	Already Do (%)
Glove Box	Room Door	13. Locate glove box just inside room door.	· Glove box should be located in a consistent position relative to the room door in all patient rooms. · Glove box should be located such that it does not stick out from the wall where it can catch on IV's, beds, etc. passing through the entryway.	· Allows PPE to be donned prior to interacting with patient.		91%	50%
Container for non-contam-inated soiled linen	Room Door	14. Locate soiled linen container near entry door.	· A separate bagging system is used for contaminated soiled linen.	· Allows soiled linens to be easily removed from the room. · Less disruption of staff working in the room.	· Reduces odors for patients and visitors. · Less disruption of the patient when soiled linen is removed.	50%	24%
Status Indicator - Room Activity	Room Door	15. Provide an indicator outside the room door that can alert staff to the occurrence of a procedure or activity in the room that should not be interrupted.	· Indicator system should be clearly visible prior to room entry. · Indicator system should be consistent and uniform across patient rooms. · Only staff should be able to turn the indicator on.	· Allows staff to complete procedures without interruptions. · Allows staff to determine when a room or a patient is accessible.	· Allows for high quality care. · Supports patient privacy.	78%	33%

Table 9. Patient Room Entryway Guidelines							
Primary Item	Secondary Item	Design Guideline	Design Constraints	Why (Staff)	Why (Patient)	Easy to Do (%)	Already Do (%)
Status Indicator - Patient Status	Room Door	16. Provide a patient status indicator outside the room door that can alert staff and visitors to restrictions and precautions relative to patient status.	· Indicator system should be clearly visible prior to room entry. · Indicator system should be consistent and uniform across patient rooms. · Staff should be able to easily change indicator status. · New status categories should be easy to create.	· Reduces the risk of staff exposures to infectious diseases and other hazardous conditions. · Supports appropriate patient care.	· Reduces risk of having procedures delayed or associated complications. · Reduces risk of violating restrictions place on patients due to their condition.	81%	35%

Table 10. Patient/Clinical Area Guidelines							
Primary Item	Secondary Item	Design Guideline	Design Constraints	Why (Staff)	Why (Patient)	Easy to Do (%)	Already Do (%)
Bed	Window	1. Locate patient bed such that the patient can see out of the window without assuming an awkward posture.	· Provide 4 feet of clearance on the primary access side, and 3 feet of clearance on the distal side and the foot of the bed (Ref). · Must also comply with patient/clinical recommendations 2 and 3.		· Published data support the importance of exterior views on patient satisfaction, reducing confusion for patients with dementia, and maintaining circadian rhythm.	50%	52%
Bed	Room Door	2. Locate patient bed such that the patient can see who is entering the room.	· Need to preserve the patient's sense of privacy from people in the hallway. · Must also comply with patient/clinical recommendations 1 and 3.	· Being able to see who is entering the room prevents staff from startling the patient.	· Enhances patient's feeling of security.	58%	44%
Bed	Sleeper Sofa	3. Locate patient bed such that the patient can communicate with people in the family zone.	· There needs to be 4' on the primary access side, and 3' on the distal side and the foot of the bed (Ref). · Must also comply with patient/clinical recommendations 1 and 2.	· Facilitates staff communicating with the patient and family members at the same time without asking family members to move.	· Enhances patient's ability to communicate with family & visitors sitting on the sofa.	78%	54%
Recliner	Bed	4. Allow space for the recliner to be positioned near the bed on either side.	· Recliner needs to move easily and have locking casters. · When positioned near the bed, someone sitting in the recliner should be able to comfortably view the TV.	· Facilitates moving the patient between the bed and the recliner.	· Reduces patient fall potential when getting in and out of recliner. · Allows visitor to sit comfortably near the patient while watching TV with the patient.	22%	39%

Table 10. Patient/Clinical Area Guidelines							
Primary Item	Secondary Item	Design Guideline	Design Constraints	Why (Staff)	Why (Patient)	Easy to Do (%)	Already Do (%)
TV	Bed	5. Position the TV so that the patient can view it comfortably when sitting or lying in bed or the recliner.	· TV should not be blocked by staff as staff perform their normal activities in the room. · Patients may have physical limitations that may limit viewing angles. · Consider the distance from the TV. · Position/angle TV to avoid glare on the TV screen from overhead lights and the window. · TV height should prevent unintended contact with equipment, be out of reach of small children, and allow for easy cleaning.	· Environmental services staff need to be able to clean the TV. · Staff can use TV as a positive distractor for their patients.	· Patients may only be capable or comfortable lying on one side of their body. · Avoid neck discomfort for patients.	86%	65%
TV	Visitor Seating	6. Position the TV so that the patient's visitors can view it comfortably while seated.	· TV should not be blocked by staff as staff perform their normal activities in the room. · Consider the distance from the TV. · Position/angle TV to avoid glare from overhead lights and window on the TV screen. · TV height should prevent unintended contact with equipment, be out of reach	· Environmental services staff need to be able to clean the TV. · Out of child reach helps keep the TV clean.	· Patient's visitors need to comfortably view the TV (see visitor seating)	45%	52%

Table 10. Patient/Clinical Area Guidelines							
Primary Item	Secondary Item	Design Guideline	Design Constraints	Why (Staff)	Why (Patient)	Easy to Do (%)	Already Do (%)
			of small children, and allow for easy cleaning.				
Visual barrier (e.g. privacy curtain)	Bed	7. Provide a visual barrier, such as a privacy curtain, that affords privacy from the hallway and family seating area when needed or desired.	· Visual barrier should be easily cleanable or disposable to facilitate providing each patient with a clean privacy curtain. · Visual barrier(s) should block view of bed from the door and the family zone.	· Provides patient privacy during procedures in the room.	· Provides the patient with privacy from the corridor and from their visitors (see family zone).	70%	52%
White-board	Bed	8. Position whiteboard such that it can be easily viewed by staff and patients, and easily updated by staff.	· Patients need to see the whiteboard comfortably when sitting or lying in bed or the recliner, perhaps without corrective eyewear. (see communication board recommendations below). · Position whiteboard such that it is not erased inadvertent contact by people walking by.	· Informs staff who is on the care team. · More easily kept up to date when it is in an easily accessible location.	· Allows patients to easily view information on the board (e.g. date, daily goals, and names of care team members).	76%	56%
IV Pole (+pumps and/or bags)	Bed	9. Provide space for the IV pole(s) next to the bed.	· The IV pole may need to be on either side of the bed.	· Reduce the need to replace IV site after accidental IV removal	· More comfortable for the patient to have the IV pole on the same side as the IV.	86%	57%

Table 10. Patient/Clinical Area Guidelines							
Primary Item	Secondary Item	Design Guideline	Design Constraints	Why (Staff)	Why (Patient)	Easy to Do (%)	Already Do (%)
Sharps Container	Bed	10. Choose a sharps container location that allows staff to easily dispose of sharps while working at the patient's bed.	· Do not locate the sharp container above or in close proximity to visitor and sitter seating.	· Facilitates the appropriate disposition of the sharps with minimal steps required by staff who are working with the sharps.	· Reduces the likelihood of a head injury when sitting in or standing up from the visitor seating. · Reduces the risk of needle-stick injuries in visitors when staff are disposing of sharps.	66%	44%
Work Surface (staff work)	Bed or Recliner	11. Provide a staff-specific horizontal work surface that is proximal to or can be positioned near the patient's bed or recliner, and near the anatomical site of the procedure.	· Should be in close proximity to the patient · Should be able to be positioned such that staff can control patients access to the surface, for example, when necessary to avoid contamination. · Location of the surface does not require the caregiver to turn away from the patient to access the sterile items on the work surface.	· Provides a dedicated place to set down tools and materials needed for patient care. · Minimizes staff turning away from the patient.	· Patients do not need to share their tray table space. · Lowers risk of patient infection.	46%	26%
Seating	Bed	12. In addition to space for the recliner, provide space for visitor/staff seating, in addition to the patient's recliner, in close proximity to the patient's bed.	· Needs to accommodate anthropometric variability and disability.	· Allows staff to direct access to the patient.	· Allows visitors to sit with and have eye level interaction with patients.	60%	54%

Table 10. Patient/Clinical Area Guidelines							
Primary Item	Secondary Item	Design Guideline	Design Constraints	Why (Staff)	Why (Patient)	Easy to Do (%)	Already Do (%)
Seating	Bed	13. In addition to the sleeper sofa, provide easily movable visitor/staff seating for at least two people.	· This seating should be dedicated to the specific patient room. · Chairs should accommodate individuals of varying size and support a range of sit-to-stand abilities. · This does not include seating for a sitter which should have casters and should not be stored in the room.	· Allows staff to sit and have eye level interaction with patients.	· Allows visitors to sit with and have eye level interaction with patients.	33%	22%
Headwall	Bed	14. Provide a split headwall that duplicates the medical gases and electrical services on both sides of the bed.	· Medical gas control and flow meters, as well as electrical outlets should be between waist and chest height.	· Reduces reaching, bending, and twisting.	· Moves the cords to the side of the patient.	33%	31%
Outlets	Bed	15. Provide an adequate number of electrical outlets for staff use on the headwall and other locations within the room at waist level or above.	· Needs to accommodate multiple pieces of hospital equipment that should not be unplugged. · Needs to accommodate staff bringing specialized equipment (i.e. imaging) into the room. · Minimum number for each patient bed location is dictated by the National Electrical Code.	· Allows staff to easily plug in their equipment (e.g. portable x-ray equipment). · Removes the need to ask nurses what can be unplugged by other staff who need to access an outlet.	· Prevents accidentally unplugging life-sustaining equipment (i.e. ventilators)	71%	41%

Table 10. Patient/Clinical Area Guidelines							
Primary Item	Secondary Item	Design Guideline	Design Constraints	Why (Staff)	Why (Patient)	Easy to Do (%)	Already Do (%)
Outlets	Bed	16. Provide an adequate number of electrical outlets that are accessible by the patient when in bed or in the recliner.	· Need to be able to accommodate up to 4 electronic devices that might be used by patient or visitors. · Outlets need to be protected from liquid spills.	· Reduces the demands on hospital staff for assistance with plugging in or retrieving charged items from locations out the patient's reach.	· Patients can operate/charge their electronic devices. · Potentially reduces patient falls as they are not getting out of bed to plug in or retrieve their electronic devices.	58%	24%
Lighting Control	Bed	17. Provide the patient with control of the electric lighting, including ambient room lighting and reading light, from the bed and the recliner.	· Patient cannot control the over-the-bed exam lighting, and night lighting. · Lighting controls should be clearly labled and mapped to room lighting locations. ·Configuration, placment, and mapping of lighting controls should be consistent across all patient rooms in the facility.	· Reduces staff confusion regarding lighting controls. · Reduces the patient's dependence on hospital staff.	· Likely reduces falls as patients will not need to get out of bed to turn off/on lights or navigate in the dark. · Provides patient control over lighting. · Provides patient the ability to read or other activities without disturbing others in the room.	69%	33%
Control Pendant	Window Coverings	18. Provide the patient with remote control of the exterior window shades/curtains from the bed and the recliner.	· A secondary control is available for staff to override patient control when appropriate (e.g. during imaging procedures).	· Reduces the patient's dependence on hospital staff.	· May reduce falls as patients will not need to get out of bed to control window shades. · Enhances patient and visitor comfort and ability to sleep.	29%	17%

Table 10. Patient/Clinical Area Guidelines							
Primary Item	Secondary Item	Design Guideline	Design Constraints	Why (Staff)	Why (Patient)	Easy to Do (%)	Already Do (%)
Control Pendant	Temperature Control	19. Provide the patient with remote control of the room temperature from the bed and the recliner.	· Limit control within a reasonable range given the patient's condition. · A secondary control is available for staff to override patient control when appropriate.	· Limiting the range allows for comfortable working conditions for staff. · Reduces patient complaints and nurse call requests to staff about room temperature. · Reduces clinical staff complaints to engineering staff about room temperature. · Reduces the demands on staff for blankets, etc.	· Enhances patient comfort. · Limiting range facilitates visitor comfort. · *May reduce falls as patients will not need to get out of bed to control thermostat.*	20%	13%
Clock	Bed	20. Position wall clock in view of patient and staff.	· Should be large enough to see without glasses. · Clock should distinguish between am and pm. · Not all patients can interpret an analog clock. · Nursing personnel need a means to count seconds.	· Staff use the clock when working with patients.	· Allows patient to maintain daily rhythm. · Allows patient to keep track of time.	97%	54%
Lighting	Nightlight	21. Provide nightlighting in the patient room (in addition to the nightlight in the bathroom).	· Automatic	· Allows staff to safely move around the room. · Allows staff to not disturb sleeping patients and visitors when coming into or working in the room.	· Allows patients and visitors to safely move around the room.	77%	50%

Table 10. Patient/Clinical Area Guidelines							
Primary Item	Secondary Item	Design Guideline	Design Constraints	Why (Staff)	Why (Patient)	Easy to Do (%)	Already Do (%)
Electrical cord support	Bed	22. Provide a cord support system to keep electrical cords and other cords (e.g. pendant, compression pumps) that are under the bed off the floor.	· Keep cords and cables free from any moving bed parts. · Cord support system should be easily accessible.	· Facilitates cleaning the floor under the bed. · Removes trip hazards. · Makes it easier to move the bed short distances.	· Removes trip hazards. · Make it easier for patient to position tray table.	53%	19%

Table 11. Bathroom Guidelines							
Primary Item	Secondary Item	Design Guideline	Design Constraints	Why (Staff)	Why (Patient)	Easy to Do (%)	Already Do (%)
Bathroom Door	Door	1. Use a sliding (barn style) door rather than a hinged door.	· Door needs to be opaque. · Door should limit transmission of bathroom sounds. · Door should move easily - consider the force required to move the door.	· Less space is taken in the room to accommodate door swing. · Removes the need to step back from the door when opening the door. · Preferred by staff where there is an inboard bathroom and the swinging door would block the view of the patient in bed from the hallway.	· Less effort to close the door after entering the bathroom to have visual and auditory privacy. · Patients do not have to back up after opening door to enter the bathroom. · Patients believe it would be easier to open and close the bathroom door. · Patients have reported an inability to open/close the door. · Health conditions can restrict physical activities including moving heavy doors.	32%	17%
Bathroom Door	Door	2. Position bathroom door to preserve patient privacy.		· Address staff concerns regarding patient privacy while using the toilet.	· Patients do not want visitors inside the room and people outside the room to see them while using the toilet if the door is not closed.	51%	31%
Gloves	Bathroom Door	3. Make gloves available in the bathroom near the door.	· Consistency across bathrooms of placement relative to bathroom door.	· Staff finds themselves in need of gloves in the bathroom.	· Patients are less likely to fall if staff does not have to leave the patient's side when obtaining gloves.	60%	13%

Table 11. Bathroom Guidelines							
Primary Item	Secondary Item	Design Guideline	Design Constraints	Why (Staff)	Why (Patient)	Easy to Do (%)	Already Do (%)
Bathroom Door	Bed	4. Optimize the location of the bathroom door relative to the bed.	· Distance should be close enough to avoid patients becoming fatigued. · Distance should be far enough to minimize odor in the patient/clinical zone. · No more than one turn should be required by the patient when walking from the bed to the toilet.	· Makes it easier for staff to assist patients into the bathroom. · Minimizing the number of turns makes it easier for patients with mobility limitations and therefore easier for staff to provide assistance with lower the risk of staff injury.	· Reduces potential for falls. · Minimizing the distance and the number of turns makes it easier for patients to safely get to the bathroom.	46%	35%
Toilet	Toilet	5. Position the toilet such that two caregivers can provide assistance and the magnitude of the turn required to seat the patient on the toilet is minimized.	· Privacy if the bathroom door is left open.	· Multiple staff members may need to provide toileting assistance for obese patients and/or patients who need higher levels of assistance.	· *Makes it easy for patient to get on and off the toilet seat.*	27%	19%
Toilet	Toilet	6. Minimize the turn required to sit on the toilet seat.		· Easier on staff assisting patient.	· *Makes it easy for patient to get on and off the toilet seat.*	40%	20%

Table 11. Bathroom Guidelines							
Primary Item	Secondary Item	Design Guideline	Design Constraints	Why (Staff)	Why (Patient)	Easy to Do (%)	Already Do (%)
Toilet	Toilet	7. Use a high toilet seat.	· Use ADA compliant toilet heights. · Support lids down flushing protocol to prevent aerolization of *Clostridium difficile*.	· Easier on staff assisting patient.	· *Makes it easy for patient to get on and off the toilet seat.*	68%	28%
Toilet	Toilet	8. Toilets should be floor mounted as opposed to wall mounted.	· Consider designs that can support obese people and designs that facilitate cleaning.	· Less repair of broken toilets by hospital maintenance personnel.	· Reduce patient safety concerns stemming from broken wall mounted toilets.	60%	41%
Patient Sink	Sink	9. Make the patient sink easily accessible to promote hand washing.	· Sink should be along path to exit bathroom · Provide sufficient space to allow staff to provide mobility assistance. · Provide sufficient space near the sink to accommodate both the patient and the caregiver. · Provide sufficient structural support to accommodate supporting patient weight. · ADA compliant - with no cabinets or doors under sink.	· Staff needs to be able to assist patient with all hygiene functions. · Prevent injuries to staff as they assist patient in using the sink.	· Makes it easy for patient to get to the sink to wash hands after using toilet. · Supports patient education and assistance on activities of daily living (e.g. brushing teeth).	93%	50%

Table 11. Bathroom Guidelines							
Primary Item	Secondary Item	Design Guideline	Design Constraints	Why (Staff)	Why (Patient)	Easy to Do (%)	Already Do (%)
Horizontal Surface	Sink	10. Have adequate horizontal surface and covered storage adjacent to sink for use of personal hygiene items.	· Provide rounded corners on the horizontal surface.	· Avoid staff running into sharp edge.	· Provides a dedicated place for patient hygiene items that is separate from staff workspace. · *Promotes patient's personal hygiene.*	47%	24%
Shower	Floor	11. Shower compartment/floor design needs to prevent water on the floor in other areas of the bathroom.	· Avoid trip hazards for patient and staff (e.g. water retainer lip). · Avoid design solutions that could lead to a loss of footing by caregivers and patients.	· Reduce the likelihood of staff falls. · Reduces the need for staff to dry bathroom floor or bring additional towels into the room. · Reduce the likelihood of injuries to staff as they prevent patient falls.	· Reduce the likelihood of patient falls.	38%	41%
Folding Shower Bench	Shower	12. Include attached folding shower bench or shower chair in each shower.	· ADA compliant shower chair should fold down when needed and fold up when not needed. · Need to accommodate heavier patients.	· Removes concern that shower chairs are not readily available when needed.	· Provides a place for patient to rest while in the shower.	74%	50%
Handheld Shower Fixture	Shower	13. Include hand-held fixture in shower that can be reached while sitting on shower chair.	· Handheld fixture needs to be located so the patient and the caregivers can easily reach it. · Provide a means for the water to drain from the handheld fixture when shower is completed.	· Aids staff in assisting limited mobility patient with shower.	· Reduces patient falls if patient can sit on shower chair while using hand-held fixture.	81%	44%

Table 11. Bathroom Guidelines							
Primary Item	Secondary Item	Design Guideline	Design Constraints	Why (Staff)	Why (Patient)	Easy to Do (%)	Already Do (%)
Shower	Shower Entry Way	14. Shower entry way and shower area needs to be large enough to accommodate patient and caregiver.		· Staff need to be able to assist patients with bathing.	· Allows patients to receive assistance when bathing.	42%	30%
Lighting	Nightlight	15. Provide a nightlight in the bathroom (in addition to the nightlight in the patient room).	· Nightlight should always be on when the bathroom light is off.	· Helps reduce patient falls.	· Helps patient sleep better because the bathroom light is not left on.	88%	39%
Lighting	Bathroom light	16. Provide an automatic light control sensor that detects when someone is in the bathroom.	· Can be over-ridden by the wall switch. · Should be amber or reddish.	· Allows staff to use both hands while assisting patients. · Helps reduce patient falls.	· Reduces the likelihood of patient falls. · Helps patient sleep better because the bathroom light is not left on.	81%	28%
Horizontal Surface	Shelves	17. Do not put shelves above the toilet.		· Difficult to clean if too high.	· Patient can hit their head if too low.	97%	46%

Table 12. Guidelines for the Family Area							
Primary Item	Secondary Item	Guideline	Design Constraints	Why (Staff)	Why (Visitor/Patient)	Easy to Do (%)	Already Do (%)
Sleeper Sofa	Sleeper Sofa	1. Provide a sofa that can be converted to a sleeping surface for one tall adult.	· Once converted to a sleeping surface, the sofa should not reduce floor space between the bed and the family zone. · Patient's TV should be visible from sleeper sofa.	· Overnighting visitors can assist staff in watching and comforting the patient. · It is important that the sleeping accommodations do not restrict the work area around the bed.	· Patients are less likely to fall if they are helped to the toilet by overnight visitors. · Visitors desire to stay with patients as much as possible.	61%	52%
Privacy Curtain	Bed & Family zone	2. Provide a visual barrier (e.g. privacy curtain) that separates the patient bed from the family zone.	· Should be easily cleanable or disposable.	· Allows staff to conduct procedures without asking visitors to move out of the room.	· Allows visitors to remain seated in the room during procedures while maintaining patient's privacy.	51%	20%
Horizontal Surface-Visitor	Horizontal Surface	3. Provide horizontal surface(s) that is/are dedicated for visitors use.	· Surface should be large enough for meals, reading materials, or a laptop computer. · Surface location should not interfere with staff activities.	· Reduces the need for staff to move visitors' things to create a work surface.	· Patients do not have to share their tray table surface with visitors · Visitors may need to be in the room for extended periods during which times they will need to eat, pass the time, and or work.	50%	33%
Lighting-Visitor	Lighting	4. Provide localized task lighting in the family zone.	· Lighting should be controlled by controls in the family zone. · Lighting controls should be available to the patient in the event a visitor leaves and has left the light on.	· *Allows visitor(s) and staff to independently control their lighting needs.*	· Allows visitors staying for extended periods to read, work, and eat without disturbing a patient who is sleeping/resting.	68%	30%

Table 12. Guidelines for the Family Area							
Primary Item	Secondary Item	Guideline	Design Constraints	Why (Staff)	Why (Visitor/Patient)	Easy to Do (%)	Already Do (%)
Lighting-Visitor	Nightlight	5. Provide adequate illumination for visitor movement in the room at night.	· Nightlights illuminate family and patient zones.	· Allows staff to move through the room at night without turning on the lights, disturbing the patient, or tripping on cords or visitor belongings (e.g., shoes, suitcase).	· Allows visitors to move safely through the room at night to assist patients and to access visitor toileting facilities.	37%	35%
Outlets-Visitor	Outlets	6. Provide an adequate number of electrical outlets for visitors to use near the bed, near the recliner, and in the family zone.	· Needs to accommodate multiple items that visitors may be bringing into the rooms. · Outlets should be at waist level or above.	· Reduces the risk of tripping for staff by avoiding stretching cords in the clinical zone when the visitor is sitting near the patient.	· Visitors may be in the room for extended periods and may need to charge phones or use a computer to work in the provided space.	81%	35%
TV-Visitor	TV	7. Consider providing a separate TV for visitors.	· Visitor TV should have audio only available through headphone jack.	· Headphone jack reduces noise levels for staff, particularly when patient TV is on.	· Allows visitors to watch TV while patient is resting/ sleeping or when visitors (e.g., children) want to watch something different from the patient.	27%	7%
Storage-Visitor	Storage	8. Provide adequate storage for overnight visitors.	· Storage needs to accommodate: visitor suitcase/backpack, outerwear, wet items (e.g., umbrella, boots), and hospital-provided bed linens and two pillows	· The storage keeps the room organized, trip hazard free, and the floors dry.	· Provides a clean place for visitors to place their belongings without cluttering the room.	53%	17%

Table 13. Design Guidelines for Patient and Visitor Storage					
Design Recommendation	Design Constraints	Why (Staff)	Why (Patient)	Easy to Do (%)	Already Do (%)
1. Provide storage units (e.g. closet or wardrobe) for the patient's belongings (including shoes).	· Needs to accommodate patient's luggage, coats, shoes, etc. · Position storage unit(s) (e.g. closet, shelving) for patient's items where patient can see the storage unit from the bed.	· Keeps the floor and area around the bed clear.	· Patients want to be able to keep an eye on their belongings	71%	56%
2. Provide a lockable cabinet/drawer/safe in the room.	· Needs to be large enough to accommodate a laptop computer and a purse. · Design should address concerns about inappropriate substance storage (e.g. see-through panel) · Design needs to address concerns about patient losing access (e.g. use patient ID as combination)	· Removes the burden on staff of keeping patient's items secure.	· Patients want to know their belongings are secure. · Patients want to be able to access their secured belongings on their own.	52%	20%
3. Patient needs storage within reach while in bed.	· Needs to be easily moved by staff to access patient or horizontal surface	· Reduces patient requests for items that are out of reach or inaccessible.	· Provides independent access to personal items · Protects glasses by placing them in a protective case	31%	17%

CONCLUSIONS

This project has investigated the ergonomic and productivity concerns occupational stakeholders have with the working environment within med/surg patient rooms. Currently these spaces result in challenging working conditions as healthcare providers and hospital staff perform their routine tasks. This four phase study: (1) exposed many of the specific issues and concerns across a wide range of occupations with their existing workspaces within med/surg patient rooms, (2) identified what hospital staff who work in med/surg rooms would like to see in new or remodeled med/surg patient rooms, (3) considered the patients and visitors needs within these spaces, (4) considered where there are design conflict between different occupational groups, as well as between hospital staff and the patients, with regards to the design of med/surg rooms that need to considered more carefully in future designs, and (5) produced a set of design guidelines that designers should refer to when creating new or remodeled med/surg rooms in the future.

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Published Papers

i. Patterson ES, Sanders EB-N, Sommerich CM, Lavender SA, Li J, Evans KD: [2017] Meeting Patient Expectations during Hospitalization: A Grounded Theoretical Analysis of Patient-Centered Room Elements. Health Environments Research and Design, 10, 95-110. DOI: 10.1177/1937586717696700

ii. Lavender SA, Sommerich CM, Patterson ES, Sanders EB-N, Evans KD, Park S, Umar, RZR, Li J.: [2015] Hospital Patient Room Design: The Issues Facing 23 Occupational Groups Who Work in Medical/Surgical Patient Rooms. Health Environment Research & Design Journal, 8, 98-114.

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i. Evans KD, Sommerich CM, Sanders EB, Patterson ES, Li, J., Lavender SA [2017] Opportunities for inpatient room designs that facilitate imaging technologists in providing diagnostic patient care: A mixed methods study. Journal of Diagnostic Medical Sonography, submitted for publication.

ii. Patterson ES, Sanders EB-N, Lavender SA, Sommerich CM, Park, S, Li J, Evans KD: [2017] A Grounded Theoretical Analysis of Room Elements Desired by Family Members and Visitors of Hospitalized Patients: Implications for the Modern Hospital Patient Room. Health Environments Research and Design, In review.

Manuscripts in Preparation

i. Lavender SA, Sommerich CM, Sanders, EB-N, Evans, KD, Li J, Patterson, ES: Ideal Med/Surg Patient Room Layouts and Their Innovative Features. In preparation for Heath Environment Research & Design

ii. Lavender SA, Sommerich CM, Sanders EB-N, Evans KD, Li J, Patterson ES: Med/Surg Patient Room Design: 66 Evidence Based Guidelines to Help Get it Right In preparation for Heath Environment Research & Design

Conference Proceedings/Abstracts

i. **Lavender SA,** Sommerich CM, Sanders EB-N, Evans KD, Li J, Patterson ES: [2017] Hospital Patient Room Ergonomics: Getting it right for all hospital staff working in these spaces. 2017 Expanding Research Partnerships: State of the Science. Denver, Colorado, Pg. 17.

ii. Sommerich CM, Pires AS, Lavender SA, Sanders EB-N, Evans KD, Li J, Patterson E: [2016] Architects' and interior designers' perspectives on hospital patient rooms designed by the

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iii. Lavender SA, Sommerich CM, Sanders EB-N, Evans KD, Li J, Umar RZR, Nagavarapu S, Patterson ES: [2015] Med/Surg Patient Room Layouts Identified Through a Participatory Design Process with Hospital Staff. Proceedings of the International Ergonomics Association, #605: http://ergonomics.uq.edu.au/iea/proceedings/Index_files/papers/605.pdf

iv. Patterson ES, Murray J, Park S, Sanders EB-N., Li J, Umar R., Sommerich CM, Evans KD**,** Lavender, SA (2014). Barriers to infection control due to hospital patient room factors: A secondary analysis of focus group and interview transcripts. Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 1266-1270.

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i. Lavender S*, Sanders EB-N, Sommerich C: Evidence-based Ergonomics for Patient Rooms: Addressing needs for staff, patients, family and visitors. Healthcare Design Conference, Orlando, FL, November 14, 2017.

ii. Lavender SA*, Radin Umar RZ, Sommerich CM, Sanders EB-N, Evans KD, Li J, Pires A, Patterson ES: Hospital Patient Room Design: Where Should the Bathroom be Located? 2017 Human Factors in Healthcare Conference, New Orleans, LA, March 7 2017. Authors:

iii. Patterson E*, Sanders EB-N, Sommerich C, Lavender S, Evans K, Li J: Identifying Unmet Patient Expectations via Critical Review of five Simulated Hospital Rooms. 2017 Human Factors in Healthcare Conference, New Orleans, LA, March 7 2017.

iv. Patterson E*, Sanders EB-N, Sommerich, C, Evans K, Lavender S, Li J: The Patient-Centered In-Bed Environment: A participatory design approach. 2017 Human Factors in Healthcare Conference, New Orleans, LA, March 7 2017.

v. Lavender S, Sommerich C., Patterson, E*, Evans K, Li J: The Environmental Services Perspective on Hospital Patient Room Design: A Mixed-Methods Approach. Poster presented by Patterson at 2017 Human Factors in Healthcare Conference, New Orleans, LA, March 7 2017.

vi. Lavender SA, Sommerich CM & Sanders EB-N: Med/Surg Patient Room Layouts Identified through a Participatory Design Process with Hospital Staff. Healthcare Design Conference – Washington, DC, November 17, 2015.

vii. Lavender SA*, Sommerich, CM, Sanders EB-N, Evans KD, Li J, Radin Umar RZ, Nagavarapu S, Patterson ES: Eyebrow-Raising Patient Room Design Features Desired by Hospital Staff, Poster presented at Healthcare Design Conference, 2015.

viii. Lavender SA*, Sommerich CM, Sanders EB-N, Evans KD, Li J, Radin Umar RZ, Patterson ES: Patient Room Design: The Environmental Services Perspective, Poster presented at Healthcare Design Conference, 2015.

ix. Lavender SA*, Sommerich, CM, Sanders EB-N, Evans KD, Li J, Radin Umar RZ, Nagavarapu S, Patterson ES: Eyebrow Raising Patient Room Design Concept Desired by Hospital Staff, Poster presented at Human Factors in Healthcare Conference, 2015.

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Cumulative Inclusion Enrollment Table

View Burden Statement

PHS Inclusion Enrollment Report

This report format should NOT be used for collecting data from study participants.

OMB Number: 0925-0001 and 0925-0002
Expiration Date: 10/31/2018

***Study Title (must be unique):** A Participatory Design Process Addressing Ergonomics in Hospital Patient Rooms

* Delayed Onset Study? ☐ Yes ☒ No

If study is not delayed onset, the following selections are required:

Enrollment Type ☐ Planned ☒ Cumulative (Actual)

Using an Existing Dataset or Resource ☒ Yes ☐ No

Enrollment Location ☒ Domestic ☐ Foreign

Clinical Trial ☐ Yes ☒ No **NIH-Defined Phase III Clinical Trial** ☐ Yes ☐ No

Comments: This is a final enrollment report for the data collected over the entire project period.

Racial Categories	Ethnic Categories									
	Not Hispanic or Latino			Hispanic or Latino			Unknown/Not Reported Ethnicity			Total
	Female	Male	Unknown/ Not Reported	Female	Male	Unknown/ Not Reported	Female	Male	Unknown/ Not Reported	
American Indian/ Alaska Native	2	2	0	0	0	0	0	0	0	4
Asian	7	7	0	0	0	0	0	0	0	14
Native Hawaiian or Other Pacific Islander	0	0	0	0	0	0	0	0	0	0
Black or African American	34	20	0	0	1	0	5	5	0	65
White	221	113	0	6	8	0	4	0	0	352
More than One Race	8	1	0	1	0	0	0	0	0	10
Unknown or Not Reported	1	0	0	1	2	0	12	3	13	32
Total	273	143	0	8	11	0	21	8	13	477

Report 1 of 1

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