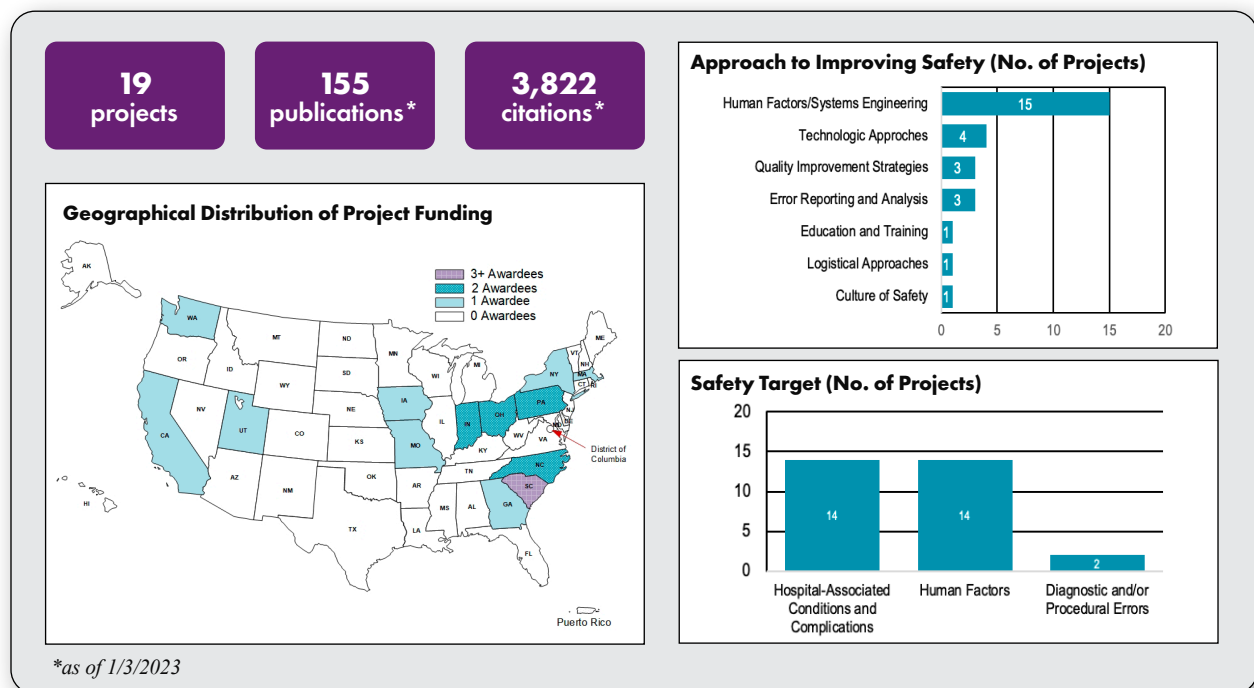# AHRQ-Funded Patient Safety Project Highlights

Improving Healthcare Safety by Enhancing Healthcare Facility Design

Overview

Research has shown that optimizing the physical, functional, and aesthetic details of healthcare facilities[i] (e.g., units, rooms, equipment, logistics, and technologies) can improve patient outcomes, reduce injuries and hospital-associated infections (HAIs), and increase provider satisfaction. Since 2000, AHRQ has supported 19 patient safety projects related to improving healthcare facility design. This publication summarizes AHRQ's investments in this promising pathway toward better care, including examples of project findings and products, collective outputs, and impacts of this work. Details about each AHRQ-supported project are available in the Appendix.

Scope of AHRQ Investments

19 projects

155 publications*

3,822 citations*

Geographical Distribution of Project Funding

- 3+ Awardees
- 2 Awardees
- 1 Awardee
- 0 Awardees

Approach to Improving Safety (No. of Projects)

Human Factors/Systems Engineering	15
Technologic Approches	4
Quality Improvement Strategies	3
Error Reporting and Analysis	3
Education and Training	1
Logistical Approaches	1
Culture of Safety	1

Safety Target (No. of Projects)

Hospital-Associated Conditions and Complications	Human Factors	Diagnostic and/or Procedural Errors
14	14	2

as of 1/3/2023

The largest number of projects was awarded to institutions in South Carolina (three), followed by Indiana, North Carolina, Ohio, and Pennsylvania (two each). At least 155 publications, which have been cited more than 3,800 times in other articles, have resulted from this research. The most prevalent approach to improving safety was human factors/systems engineering (n=15, 79%) and the most prevalent safety targets were hospital-associated conditions and complications and human factors (n=14, 74% each).[ii]

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[i] Healthcare facility design is the process of optimizing the physical, functional, and aesthetic details of entire healthcare facilities; units within facilities; or rooms, equipment, logistics, and various technologies within those facilities. Such design requires consideration of technical requirements, as well as the necessary flows of providers, patients, equipment, and information.
[ii] Human factors are the strengths and constraints in the design of interactive systems and actions involving people, tools and technology, and work environments to ensure their safety, reliability, and effectiveness.

Examples of Project Findings

This collection of work encompasses projects that have or are testing:

- Changes to the design and physical structure of healthcare facilities and units.
- Characteristics of the built environment within and around facilities that will help prevent the spread and transmission of HAIs.
- Design details that can reduce the incidence of falls, infections, and operational inefficiencies (e.g., poor location of supplies).

These AHRQ-funded projects have influenced and affected patient safety research and improvement by:

- Conducting sociotechnical analyses and modeling.
- Developing, implementing, and evaluating healthcare facility design tools, toolkits, programs, and other interventions.
- Generating new knowledge.
- Disseminating research findings.

Examples of these projects and summaries of their results are described below and organized by research themes identified in this collection of work.

Reducing Hospital-Associated Infections

AHRQ funded several projects focused on the role of healthcare facility design in preventing HAIs.

- An integrated engineering-based model developed to reduce infection rates in pediatric intensive care units determined that combinations of two or more interventions were more effective in reducing the risk of HAI compared with individual interventions.

- A systematic review of the literature indicated that barriers and spatial separation (e.g., private rooms) can decrease contact transmission of pathogens. In addition, waterborne pathogens can be controlled by maintaining optimal water temperatures and chlorination levels or by installing faucets that prevent splashing.

- One project resulted in the development of an interface for use in operating rooms that accurately recognizes surgeons' intentions to browse magnetic resonance images by examining their hand gestures, which may reduce the length of surgeries and potential for infection.

Improving Fall Detection and Prevention

AHRQ also funded projects exploring strategies for the detection and prevention of patient falls in a variety of healthcare environments.

- A computational model developed to improve patient stability and mitigate the risk of falls successfully identified the risk associated with different patient room layouts and features.

- One project produced several publications describing sensor-based technology designed to unobtrusively monitor patient activity (i.e., related to falls and fall risk) in hospital rooms of older patients.

- Another project aimed at reducing human errors that limit the effective use of protocols suggested using a sustainable design intervention for patients experiencing slips, trips, and falls (STFs) and offered a proactive problem-solving approach to reduce STFs in acute care hospitals.

Improving Information Flow and Detection

Some of the healthcare facility design projects focused on creating more efficient and effective healthcare work environments by influencing the flow and detection of information to improve clinical practice and patient safety.

- The Institute for the Design of Environments Aligned for Patient Safety (IDEA4PS) project led to improvements in the safety and quality of patient care by reducing bedside monitor alarm burden and automating surveillance of HAIs to provide information to stakeholders in near-real time.

- A Patient Safety Risk Assessment (PSRA) Toolkit was designed and tested in three hospitals to help designers ensure that new or renovated healthcare facilities support workflow, procedures, and staff capability, while also keeping patients safe from harm.

- One project launched a pilot study to integrate facility and healthcare information and found that patient safety can be improved through better coordination of healthcare facility management functions with the healthcare delivery processes.

- A new tool for medical alarm designers was found to be an effective means of interpreting standard medical alarm sounds to minimize the effect of alarm masking—a phenomenon that occurs when two similar sounds occur simultaneously.

Impacts

AHRQ-funded research in healthcare facility design has contributed to a growing body of research on the impact of the built environment on patient safety. With increased spending on healthcare construction, leaders have a great opportunity to use this research to facilitate improved designs for their facilities. The 19 projects in this collection of work have achieved their aims with varied outcomes but have collectively produced:

- Tools and toolkits for architects, designers, hospital administrators, researchers, industrial engineers, and facility managers to apply to large and small healthcare facilities.

- A greater knowledge base (e.g., publications, presentations) regarding the design of various healthcare facilities and its impact on patient care, safety, and outcomes.

- Various computational models to assess healthcare risks and adverse events related to the built environment.

In addition, the products and resources developed by this body of AHRQ-funded work have collectively helped to:

- Provide safer processes for patient care in care facilities (e.g., surveillance for falls, use of information technology).

- Decrease HAI rates and adverse events (e.g., using spatial separation, hand-gesture recognition technology).

- Promote the effective use of patient portals (e.g., MyChart Bedside).

- Provide guidelines and tools for healthcare facility designers (e.g., Safe Design Roadmap/CEO Checklist, Health Care Facility Design Safety Risk Assessment Toolkit).

To learn more about each project included in the synthesis, refer to the Appendix that follows.

Appendix

Healthcare Facility Design Project Summary

This appendix briefly describes AHRQ-funded projects related to healthcare facility design. Projects are organized first by state, then by original date of funding. In addition, the projects listed below are linked to the NIH RePORTER—an electronic tool that allows users to search a repository of federally funded research projects and access publications resulting from such funding.

Principal Investigator Organization City, State	Project Number [Type] Title	Project Period	Total Research Investment	Purpose and Key Findings/Impact	Number of Publications
California					
Health Environments Research and Design (HERD) Los Angeles, California	290-2010-000024I-2 [Purchase Order] Journal Supplement for Research on HAI/ Facility Design Topics	2013-2014	$27,600	**Purpose:** Review, edit, and manage all aspects of editorial production for a special supplement of a scholarly journal (HERD) consisting of a series of papers that focus on the role of the built environment (architecture, interior design, engineering) in the acquisition and prevention of healthcare-associated infections. **Key Findings/Impact:** The commentary for the HERD journal supplement was derived from the AHRQ-funded study titled "Understanding the Role of Healthcare Facility Design in the Acquisition and Prevention of Healthcare-Associated Infections."	1 supplement
Georgia					
Craig Zimring Georgia Institute of Technology Atlanta, Georgia	R13 HS15962 [Grant] Impacts of the Physical Environment on Health Care Final Report	2005-2006	$25,000	**Purpose:** Conduct a conference to inform key researchers, research consumers, and decision makers of the depth and breadth of the evidence; identify the measures needed to foster a vigorous and effective new field (healthcare facility design) in time to impact the large volume of hospital construction; and discuss the impacts of the hospital physical environment on healthcare outcomes and patient and staff satisfaction. **Key Findings/Impact:** Nearly 150 research areas or specific research questions were identified during the summit, with several cross-cutting themes, including: • Develop more rigorous typologies of nurse floor layout and their effect on nurse turnover, nurse walking distance and fatigue, response time, patient satisfaction, and other outcomes. • Evaluate the impact of single patient rooms on outcomes such as infection, patient falls, patient satisfaction, and nurse fatigue. • Evaluate approaches to involving patients, families, and frontline staff in the design process and how that affects the quality of care. • Examine the effects of various technologies (e.g., computers, personal digital assistants, nurse call systems) on outcomes such as workplace satisfaction, privacy, patient safety, and nurse injuries. • Study how design issues (e.g., family zones, decentralized nursing stations) affect hospital culture.	0

Principal Investigator Organization City, State	Project Number [Type] Title	Project Period	Total Research Investment	Purpose and Key Findings/Impact	Number of Publications
Indiana					
Juan Wachs Purdue University West Lafayette, Indiana	R03 HS19837 [Grant] Context-Based Hand-Gesture Recognition for the Operating Room Final Report	2010-2012	$100,000	**Purpose:** Investigate how contextual information about surgical tasks can help improve the robustness of hand gesture recognition systems and how to assess the effectiveness of this interaction. **Key Findings/Impact:** Through a series of simulation and validation studies, the investigators designed a gestural interface for browsing magnetic resonance images in the operating room. The main finding was that it is possible to accurately recognize the user's intention to perform a gesture by observing environmental cues (context) with high accuracy. The next step is to add more environmental cues, such as the position of a surgical instrument within the patient's body. Once the new contextual classifiers have been integrated into the system, a large-scale usability test must be conducted with a phantom model, such as those used in surgical training.	1
Juan Wachs Purdue University West Lafayette, Indiana	R18 HS24887 [Grant] GestureClean: A Touchless Interaction Language for the Operating Room Final Report	2016-2019	$719,536	**Purpose:** Develop a highly efficient, usable methodology for designing suitable gesture-based interfaces for the operating room and improve the understanding of how natural means of interaction affect doctors' performance in the OR. **Key Findings/Impact:** Researchers determined the typical functions of the Picture Archiving Communication Systems (PACS) by observing nine neurosurgeons (34 PACS commands), conducted a gesture elicitation study with the surgeons to identify their gestural preferences, developed Vocabulary Acceptability Criteria (VACs), and measured the usability metrics of gesture lexicons generated from VACs. Overall, statistical regression analysis showed that the gestures' qualitative property (v) scores were significantly correlated with the gestures' usability metric (u) scores ($R^2 \approx 0.4$, $p < 0.05$). Hence, usability studies can be conducted with relatively small numbers of surgeons as u scores can be estimated from v scores.	12

Principal Investigator Organization City, State	Project Number [Type] Title	Project Period	Total Research Investment	Purpose and Key Findings/Impact	Number of Publications
Iowa					
Geb Thomas University of Iowa Iowa City, Iowa	R03 HS21558-01A1 [Grant] Real-Time, Wireless, Networked Feedback for Bed Tilt Compliance Final Report	2013-2014	$99,821	**Purpose:** Identify, measure, and address two broad categories of human error that may limit the effective application of a protocol: (1) lapses or slips, which occur when the person responsible for adjusting the bed has the correct intention but forgets or incorrectly acts on the intention; and (2) mistakes, which occur when the person incorrectly believes that the bed angle is correctly set when it is not in compliance with the recommended angles. **Key Findings/Impact:** A product of this report, Hignett, et al. (2015),[iii] used a theoretical model for human factors and ergonomics (HFE) and a comparison with occupational slips, trips, and falls (STFs) risk management to discuss patient STF interventions. The results from three case studies suggest taking a similar HFE integration approach to other industries—that is, a sustainable design intervention for the person who experiences the STF event (the patient). The paper also offers a proactive problem-solving approach to reduce STFs by patients in acute hospitals.	1
Massachusetts					
Catherine Allan Boston Children's Hospital Boston, Massachusetts	R18 HS25927 [Grant] Development, Validation, and Application of a Quantitative Hazard Assessment and Remediation Tool To Mitigate Risk in the Healthcare Built Environment	2018-2023	$1,999,028	**Purpose:** Develop and validate a robust quantitative tool that can be applied to clinical spaces under design or to existing spaces to assess and remediate physical hazards. **Key Findings/Impact:** This project is ongoing, and no final report or publications are currently available.	0

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iii Hignett S, Wolf L, Taylor E, Griffiths P. Firefighting to innovation: using human factors and ergonomics to tackle slip, trip, and fall risks in hospitals. Hum Factors. 2015;57(7):1195-1207. https://pubmed.ncbi.nlm.nih.gov/26138215/. Accessed September 11, 2023.

Principal Investigator Organization City, State	Project Number [Type] Title	Project Period	Total Research Investment	Purpose and Key Findings/Impact	Number of Publications
Miissouri					
Marilyn Rantz University of Missouri Columbia, Missouri	R01 HS18477 [Grant] Technology To Automatically Detect Falls and Assess Fall Risk in Senior Housing	2009-2013	$1,989,442	**Purpose:** Validate and deploy an innovative technological approach that automatically detects when falls have occurred or when the risk of falls is increasing. By detecting falls or increased fall risk early with sensors in the home, this new technology can act as a trigger for older adults, family members, or healthcare providers to improve physical function or better manage illnesses that are precipitating falls. **Key Findings/Impact:** Seventeen publications were identified. Although the investigator's work has focused on the development and testing of technology-based systems to identify and prevent falls in the home setting, several publications also reported efforts to incorporate technology in the hospital setting for this purpose. These studies described early prototypes and development activities for using depth data collected using a Microsoft Kinect sensor to monitor patients' activity in their hospital room unobtrusively. The work also describes a novel web-based depth video rewind approach that may be useful for reviewing events that led to falls for postfall quality improvement process analyses. Preliminary data from these studies show the feasibility of using the Kinect sensors.	17
New York					
Matthew Bolton State University of New York at Buffalo Buffalo, New York	R18 HS24679 [Grant] A Formal Approach to Detecting and Correcting Simultaneous Masking in the International Electrotechnical Commission (IEC) 60601-1-8 International Medical Alarm Standard Final Report	2016-2019	$710,443	**Purpose:** Develop a computational method to systematically evaluate the reserved alarm sounds of the IEC 60601-1-8 international medical alarm standard—the standard that gives engineers instruction for creating human-perceivable auditory medical alarms—to determine when and how such alarm sounds can be totally and partially masked. **Key Findings/Impact:** According to the final report, researchers used automated proof techniques to determine if masking can occur in a modeled configuration of medical alarms. Results showed significant masking problems for both the total and partial masking of high-, medium-, and low-priority reserved alarm sounds. Researchers also showed that discovered problems can be mitigated by setting alarm volumes to standard values based on priority level and by randomizing the timing of alarm tones. They created a tool so that medical alarm designers can apply the method and findings to the design of alarm sounds. These results suggest ways to interpret the IEC 60601-1-8 reserved sounds that will minimize the effect of masking. First, for a designed configuration of alarms, alarms at a given priority should be kept as close to the same volume as possible. Second, for alarms between devices, clinical engineers should try to make similar priority alarms as close to the same volumes as possible. They should not increase the volume of a particular alarm to improve its perceivability. These recommendations will reduce the chances that any alarm will be masked.	7

Principal Investigator Organization City, State	Project Number [Type] Title	Project Period	Total Research Investment	Purpose and Key Findings/Impact	Number of Publications
North Carolina					
Douglas Kamerow Research Triangle Institute Research Triangle Park, North Carolina	290-2010-000024I-2 [Contract] Understanding the Role of Healthcare Facility Design in the Acquisition and Prevention of HAIs Final Report	2011-2013	$479,952	**Purpose:** Summarize the role of the built environment in the transmission of pathogens and discuss the impact design features could have in mitigating transmission in healthcare facilities. **Key Findings/Impact:** A final report was unavailable, but a literature review found evidence that: 1. Poor design and maintenance of the built environment can increase the risk of pathogen transmission and lead to outbreaks. 2. Even with contemporary design and maintenance, the built environment contributes to some transmission events within hospitals. 3. Novel and best practice technologies, materials, and design strategies may directly decrease the risk of pathogen transmission by reducing microorganisms in the environment. 4. Optimal design may indirectly decrease the development of HAIs by influencing human behaviors to decrease person-to-person transmission. More research is needed, as the best methods for leveraging strategies and design features aimed at interrupting the transmission of pathogens remain unresolved. Increased multidisciplinary dialogue during facility design, planning, and construction phases is also needed to fully analyze the benefits and drawbacks of new design strategies.	0
Prithima Mosaly University of North Carolina - Chapel Hill Chapel Hill, North Carolina	R03 HS25258 [Grant] To Quantify the Impact of the Existing vs. Enhanced Work Configuration of Radiation Therapy Technicians on Workload, Situation Awareness, and Performance During Pretreatment QA Tasks Final Report	2018-2020	$99,335	**Purpose:** Assess the impact of modifications to workflows, workspace design, and environment factors on radiation therapy technicians (RTTs), workload (WL), situational awareness (SA), and performance during pretreatment quality assurance (QA) tasks in a simulated environment. **Key Findings/Impact:** Limited research has been done to quantify the impact of ergonomic enhancements to workspaces and workflows on physical stressors, mental WL, SA, and performance of RTTs. This study was the first of its kind in the radiation therapy domain to assess the effects of workspace configuration on physical stressors, mental WL, SA, and performance. The results suggest that ergonomically designed workspaces and careful consideration of workflows may reduce physical stressors and improve RTTs' timeout compliance.	3

Principal Investigator Organization City, State	Project Number [Type] Title	Project Period	Total Research Investment	Purpose and Key Findings/Impact	Number of Publications
Ohio					
Ann Scheck McAlearney (Formerly Susan Moffat-Bruce) Ohio State University Columbus, Ohio	P30 HS24379-01 [Grant] The Institute for the Design of Environments Aligned for Patient Safety (IDEA4PS) Final Report	2015-2020	$3,963,276	**Purpose:** Improve clinical practice by designing, testing, and exploring the type and kind of information flows that result in a more efficient and effective healthcare work environment. The project includes three specific subprojects. **Key Findings/Impact:** The development of IDEA4PS provided foundational infrastructure to connect stakeholders across The Ohio State University and Wexner Medical Center to conduct rigorous research in the context of practice. IDEA4PS reduced the alarm burden for bedside monitors and Secondary Alarm Notification System delivered on nurses' phones, thereby allowing clinicians to focus on meaningful events over the din of background noise, which led to improvements in the safety and quality of patient care. IDEA4PS automated surveillance of hospital-associated infections to provide results in near real time to stakeholders and to explore different visualizations for surveillance results. IDEA4PS also explored how hospitalwide use of MyChart Bedside, an inpatient patient portal, affected the provider work system and processes. This Patient Safety Learning Laboratory's (PSLL) work has resulted in at least 72 peer-reviewed journal publications, with more than 770 citations in other publications; nearly 90 presentations at institutions and conferences; and creation of a website.	77
Sara Bayramzadeh Kent State University Kent, Ohio	R18 HS27261 [Grant] Towards a Model of Safety and Care for Trauma Room Design	2019-2023	$2,445,076	**Purpose:** Investigate obstacles to improved patient safety outcomes in trauma rooms and develop a design guide model that serves as a primary source to direct the design of the next generation of trauma rooms. **Key Findings/Impact:** This project is ongoing, and no final report or publications are available yet.	4
Pennsylvania					
Chinemelu Anumba Pennsylvania State University, Hershey Medical Center Hershey, Pennsylvania	R03 HS19074 [Grant] A Pilot Study for Integrating Facility Information With Healthcare Information Final Report	2010-2011	$100,000	**Purpose:** Investigate the links and overlaps between facilities management information and healthcare delivery process information with a view to identifying scenarios and use cases that can be used to develop systems and mechanisms to maximize the opportunities to improve patient safety. **Key Findings/Impact:** The study established that it is possible to improve patient safety by better coordinating facilities management functions in a healthcare facility with healthcare delivery processes (e.g., monitoring of critical facilities to ensure that problems are caught and addressed early, effective communication between healthcare facility management personnel and clinical personnel).	3

Principal Investigator Organization City, State	Project Number [Type] Title	Project Period	Total Research Investment	Purpose and Key Findings/Impact	Number of Publications
Seth Hostetler Geisinger Health System Danville, Pennsylvania	R18 HS21660-01A1 (originally listed as R18 HS021660-01) [Grant] Bridging Care Support and Care Delivery With Engineered Logistics and Technology	2013-2017	$738,526	**Purpose:** Conduct a lean redesign of Geisinger Clinic's supply delivery, support service operations, and clinical workflow on inpatient units. Project HELP's goal is to remove clinicians from support service activities (e.g., pharmacy, lab, and linen services) and reinvest this time in patient care activities. **Key Findings/Impact:** A final report was not available, and publications could not be found.	0
South Carolina					
Anjali Joseph Center for Health Design Clemson, South Carolina	R13 HS20322-01A1 [Grant] Designing for Patient Safety: Developing Methods To Integrate Patient Safety Concerns Into the Facility Design Process Final Report	2011-2012	$49,385	**Purpose:** Develop a strong foundation for integrating patient safety considerations into the facility design process by organizing a national seminar attended by multidisciplinary stakeholders. **Key Findings/Impact:** Key activities for this project resulted in a list of 14 design tools and approaches, 16 opinion papers that were compiled into a document called Perspectives on Designing for Patient Safety, and a seminar focused on design for patient safety. Participants reached consensus during the seminar that time and effort focused on patient safety issues are needed during the predesign phase (strategic planning, master planning, operational planning, and programming) of healthcare facility design projects. A Safe Design Roadmap/CEO Checklist was also developed to provide healthcare administrators with questions to ask during the different design stages in a typical healthcare facility project (from strategic planning to occupancy) to improve patient safety.	0

Principal Investigator Organization City, State	Project Number [Type] Title	Project Period	Total Research Investment	Purpose and Key Findings/Impact	Number of Publications
Anjali Joseph Center for Health Design Clemson, South Carolina	R13 HS21824 [Grant] Developing and Disseminating a Patient Safety Risk Assessment (PSRA) Toolkit Final Report	2012-2015	$295,546	**Purpose:** Develop a patient safety risk assessment (PSRA) toolkit to help eradicate patient harm. The toolkit includes an evidence-based design strategy framework (Safe Design Roadmap), a proactive Patient Safety Risk Assessment tool, instructions and methods for its use, user guides and white papers, and an educational platform with case studies to accelerate the adoption, integration, and institutionalization of the physical environmental design. **Key Findings/Impact:** Three seminars were conducted between 2012 and 2015, the Safety Design Roadmap was further developed, and a safety risk assessment (SRA) tool was designed and tested in three hospitals. It was later disseminated via an online platform. Overall, the SRA testing revealed significant opportunity for a proactive process that focuses on safety to positively affect the approach to healthcare facility design. A key product of this work was the 2017 Health Care Facility Design Safety Risk Assessment Toolkit, which aims to help designers ensure that new or renovated healthcare facilities support workflow, procedures, and capability while keeping patients and staff safe from harm. The toolkit targets six areas of safety—infections, falls, medication errors, security, behavioral health, and patient handling—as required by guidelines of the Facility Guidelines Institute. It also addresses more than 200 potential environmental considerations for the built environment and provides a quality check tool that allows teams to prioritize risks within budget constraints.	2

Principal Investigator Organization City, State	Project Number [Type] Title	Project Period	Total Research Investment	Purpose and Key Findings/Impact	Number of Publications
Anjali Joseph Clemson University Clemson, South Carolina	P30 HS24380-01 [Grant] Realizing Improved Patient Care through Human-centered Design in the OR (RIPCHD.OR) Final Report	2015-2021	$3,994,557	**Purpose:** Develop an evidence-based framework and methodology for the design and operation of operating rooms to improve perioperative outcomes, including surgical site infections, surgical errors, and staff injuries. **Key Findings/Impact:** The work products and research publications developed as part of the RIPCHD. OR PSLL represent the most comprehensive body of work related to operating room work systems design. It found that operating room size, room design, and layout may create barriers to task performance, potentially contributing to the escalation of disruptions and errors in the OR. This PSLL has produced a range of innovative products, including the design of a safer and more efficient OR prototype, implementation in a new surgery center, a web-based safe OR design tool, an "Innovations in Surgical Environments Workshop," well-illustrated online books, 23 peer-reviewed publications, and more than 60 conference presentations. These different modes allowed this work to be disseminated quickly and effectively and has already made a significant impact on the industry. In addition, the postoccupancy evaluation of the new pediatric Medical University of South Carolina Ambulatory Surgery Center in Charleston demonstrated a reduction in disruptions and improved use of OR space. The lessons learned from this project have also influenced the design of several surgery center projects around the United States and will provide the foundation for future research related to other types of OR environments such as hybrid ORs and robotic-assisted surgeries. The research and prototype design framework and methods that were developed, used, and refined through this project are envisioned to be applicable to other healthcare spaces where critical patient care is delivered.	23
Utah					
Janice Morse University of Utah Salt Lake City, Utah	R18 HS25606 [Grant] Reconfiguring the Patient Room as a Fall Protection Strategy To Increase Patient Stability During Ambulation	2018-2023	$1,990,324	**Purpose:** Increase the safety of a hospital room for patient mobility between the bed and the bathroom, using innovative simulation strategies and patient-centric design. **Key Findings/Impact:** Although this project is ongoing, and no final report or publications are available yet, the work has resulted in three peer-reviewed publications. One study created a computational model to evaluate patient room design layout and features that contribute to patient stability and mitigate the risk of falls. This preliminary model successfully identified the risk associated with different room layouts and features. The second study examined the effect of hospital bed height as it relates to falls for patients with Parkinson's disease. The study found that higher beds required less strength, balance, and agility than lower beds, which were more likely to lead to falls for patients with Parkinson's disease.	3

Principal Investigator Organization City, State	Project Number [Type] Title	Project Period	Total Research Investment	Purpose and Key Findings/Impact	Number of Publications
Washington					
Christina Mastrangelo University of Washington Seattle, Washington	R03 HS15732 [Grant] Developing an Integrated Engineering-Based Model To Reduce Infections in the ICU Final Report	2007-2009	$99,394	**Purpose:** Develop an engineering-based, systems-level methodology that models the likelihood of infection transmission within pediatric intensive care units. The model strategically used systems engineering tools to measure, characterize, and optimize the environment to improve performance by reducing infection rates. **Key Findings/Impact:** The findings show that combinations of two or more interventions are more effective in reducing the risk of HAI compared with the effectiveness of individual interventions. Interventions included using antimicrobial-impregnated central venous catheters (CVCs); limiting the use of Foley catheters; using oral care kits with cetylpyridium antiseptic rinse agent; and using antimicrobial-impregnated peripherally inserted central catheters (PICCs) and Broviac lines. Findings also show that interventions oriented toward reducing the risk of HAIs due specifically to CVCs, mechanical ventilation, PICCs, Foley catheters, patient length of stay, hemodialysis/continuous renal replacement therapy, and Broviac lines are more likely to succeed in reducing the overall risk of HAIs. This research also demonstrated the viability of combining simulation modeling, risk analysis, and statistical analysis techniques into a complex system modeling framework as a tool for assessing the risk of HAIs.	1