The National Patient Safety Foundation Research Grants Program seeks to stimulate new, innovative projects directed toward enhancing patient safety in the United States. For the past 14 years the program has supported innovative studies leading to the prevention of human errors, system errors, patient injuries, and the harmful consequences of such adverse events in the health care setting. The National Patient Safety Foundation Agenda for Research and Development in Patient Safety, which was launched at the program’s inception, set forth a broad agenda focused around investigator-driven research by encouraging the development of a cadre of expert investigators who are committed to research on patient safety.

Since 1998, the NPSF Research Grants Program has supported 38 research projects with nearly $3.8 million in grant funding. Many of these grants have been awarded to interdisciplinary teams to support research on diverse topics in areas such as medication errors, organizational design, and disclosure or communication issues. The outcomes and successes of the funded work, which is often unique and cutting edge, is evidence that this grant program has provided significant value to the marketplace and greatly impacted the medical field and the lives and careers of investigators who have gone on to become leaders in patient safety.

The following pages illustrate the commendable work of the 38 projects NPSF has funded and offer summaries of the projects and progress to date. We thank those who have worked diligently over the years to add to and improve upon knowledge in the field of patient safety. We are also most appreciative of the dedication and valuable time provided by our Research Grants Program Committee and of those who have supported the projects through generous contributions, all of which has helped to support these grants.

As the NPSF Research Grants Program continues to seek and support innovative and unique research in patient safety, we encourage you to join us in our efforts to stimulate, develop, and transform the body of patient safety knowledge.

Sincerely,

Bruce L. Lambert, PhD
Chair, NPSF Research Grants Program

For more information about these projects, partnership opportunities, and the current grant cycle, please visit www.npsf.org or contact NPSF at 617.391.9900.
In this summary, grants are listed in chronological order.

An index by principal investigator, along with a list of direct and indirect results of NPSF-funded research, begins on page 24.
ABOUT THE NATIONAL PATIENT SAFETY FOUNDATION
RESEARCH GRANTS PROGRAM

The National Patient Safety Foundation Research Grants Program promotes studies leading to the prevention of human errors, system errors, patient injuries, and the consequences of such adverse events in the health care setting. The program’s annual grant cycle includes a two-stage application process. In the first stage, Letters of Intent (LOIs) are solicited for research and development that is broadly related to identifying the causes of preventable injuries and errors and/or developing prevention strategies and methods to implement them. From these LOIs, a subset are selected for preparation of a final proposal.

Letters of Intent
To date, NPSF has received over 1,000 investigator-driven letters of intent. Projects submitted for consideration involve a wide range of patient safety issues and propose diverse approaches to investigating these issues. Common subject areas addressed by LOIs submitted in 2011 included clinical teamwork and communication, safety culture, coordination of care, and medication safety. The most common type of research intervention among LOIs submitted in 2011 involved education and training. Other commonly proposed interventions included process or product redesign and application of technology/informatics.

NPSF-Funded Projects
The 38 research projects supported by the NPSF Research Grants Program to date have varied widely and have addressed such important issues as leadership and accountability, patient and provider communication, and safety culture. Frequent areas of focus among NPSF-funded projects include human factors in organizational or system design, communication and teamwork, clinical cognition, and health information technology. Many NPSF-funded projects have addressed issues that span across the general medical domain. A number of projects have focused on anesthesiology. Other funded projects have focused on the clinical domains of psychiatry, geriatrics, and occupational/physical therapy. While the specifics of each project are unique, the common thread among them has been the investigative team’s commitment to advancing the science of patient safety and its applications to practice. For many investigators, these projects have become stepping stones to continued work in this important field of study.
Identification and Validation of Risks to Patient Safety during Care Transitions of Older Adults Receiving Skilled Home Healthcare Services after Hospital Discharge

Alicia Arbaje, MD, MPH
Johns Hopkins University School of Medicine

Errors during care transitions of older adults are common, costly, and sometimes lethal. Although there is a strong movement to improve care transitions (the movement of a person from one healthcare setting to another), the mechanisms by which to achieve better outcomes are not entirely clear. The aging of the population is leading to greater reliance on care delivered in the home, a poorly understood healthcare delivery setting. For unclear reasons, older adults who require skilled home healthcare (SHHC) services (e.g., nursing, physical therapy) after hospital discharge are among those at highest risk of experiencing suboptimal outcomes, including early rehospitalization. While there has been research on improving care transitions from hospital to home, interventions are often disease-specific or focus primarily on hospital-based discharge planning. There is essentially no research conducted on hospital/SHHC transitions.

We propose to take a systems approach to investigate factors threatening patient safety during care transitions in order to develop sustainable interventions. The conceptual framework guiding this study is the Systems Engineering Initiative for Patient Safety model, based on the field of human factors and systems engineering, which seeks to proactively understand risks in complex systems. The long-term goals of the proposed study are to (1) increase situational awareness by alerting SHHC organizations and providers in real time of risky care transitions possibly resulting in poor patient satisfaction or rehospitalization, and (2) improve care coordination through the development of interventions to improve care transitions.

**SPECIFIC AIM 1:** Identify risks to unsafe care transitions of older adults who receive SHHC services after discharge from the hospital. We define “risks” broadly to include factors related to various levels of the system: (1) clinician, patient/caregiver, (2) task and job design, (3) tools and technology used, (4) environment, and (5) organization. To achieve this aim, we will use prospective risk identification methods: (a) direct observations of the SHHC admissions process from the hospital to the patient’s home; and (b) semi-structured interviews of older adults/caregivers/SHHC providers.

**SPECIFIC AIM 2:** Develop and pilot test an innovative index that will enable SHHC agencies to identify older adults at high-risk for suboptimal care transitions and target them for intervention during the hospital/SHHC transition. To develop the index, we will prioritize the risks identified in SA1 through focus groups using Health Care Failure Modes and Effects Analysis (HFMEA), a well-known method used to identify solutions to safety problems.

This scientific study has the potential to substantially improve patient safety. It is innovative in its focus on older adults and in its use of a multi-disciplinary team, multi-center sites, and human factors methods to understand risks in SHHC and home settings. Examples of the index's potential for expanded use include the following: organizing the scheduling of SHHC visits, facilitating information exchange among healthcare providers, design of patient/caregiver educational tools, design of the home environment, determination of home healthcare workflow, and evaluation of interventions addressing safety violations. Thus, study findings have the potential for applicability to a broader group of patients discharged from hospital to home and requiring complex care.

Management of Distractions and Interruptions during Nursing Care in ICU

Mary Beth Happ, PhD, RN, FAAN
University of Pittsburgh School of Nursing

**NPSF Board Grant**

**Background:** Distractions and interruptions pose increasing threats to cognitive processing and safe, error-free patient care in critical care settings where information technology is ubiquitous and the environment is complex and chaotic. Recent studies suggest that distraction and interruptions in the clinical setting are inevitable and some interruptions may be valuable. The construction of safe care environments and processes requires...
an understanding of the sources and purpose of distraction and interruption and ways that nurses manage these challenges. There are, however, few studies on distraction and interruption management among nurses in the ICU.

**Objectives:** This sequential mixed methods study addresses the problem of distraction and interruption in adult critical care settings. Specific aims are to describe: (1) the sources of nurse distractions/interruptions, (2) content or purpose of the distractions/interruptions, (3) types of interactions affected by distractions/interruptions (e.g., medication preparation/administration, pain-symptom assessment, technical tasks-caregiving), (4) nurse and patient characteristics associated with distractions/interruptions, (5) strategies for handling and resuming the distracted/interrupted tasks, (6) advantages and disadvantages of interruption during bedside care in the ICU. We propose two studies.

**Methods:** Study 1 is a quantitatively driven secondary analysis of an existing set of 356 video recorded observations (60 hrs.) of bedside care and communication between 89 nurse-patient dyads in two ICUs, a medical (MICu) and a cardiothoracic ICU (CT-ICU). Patients were unable to speak due to tracheal intubation to facilitate respiratory care. Nurses (n=30) had a minimum of 1-year critical care experience. Demographic and clinical measures (age, delirium, severity of illness) are also available in the dataset. Videos will be coded for source of distraction/interruption, content or purpose of the distraction/interruption, types of interactions or tasks interrupted, resumption of task and strategies for managing the distraction/interruption.

Study 2, a qualitative follow-up study, will provide additional “real-time,” semi-structured observations and nurse focus group interviews to validate and further develop the patterns of managing distraction and interruption at the bedside derived from Study 1 and will be conducted in the same settings as the first study. In Study 2, observations will be conducted with 10 nurses equally distributed in the MICU and CT-ICU. Approximately 20 nurses from these units will participate in focus group interviews. Qualitative content analysis will be applied to observational data and focus group transcripts. The research team melds expertise from critical care nursing, biostatistics, public health, and cognitive psychology.

**Expected Outcomes:** The findings will significantly impact critical care patient safety by (1) providing a more complete understanding of distraction and interruption during bedside care; (2) identifying strategies for preventing and managing nurse disruption and interruption in the ICU and (3) providing practice-based evidence for the development of a program to improve clinicians’ safe management of distraction and interruption.

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**2010–2011**

**Patient Handoffs: The Impact of a Fresh Perspective on Patient Mortality in Critical Care Settings**

Emily S. Patterson, PhD, James M. O’Brien Jr., MD, MSc
Ohio State University, School of Health and Rehabilitation Sciences, College of Medicine

**Hospira Research Grant**

The overarching goal of this research project is to develop training for resident physicians on how to make patient handoffs during sign-outs more effective. We hypothesized that naturally occurring “collaborative cross-checking” behavior during sign-outs compensated for the negative impacts of increased patient handoffs following reduced work hours for resident physicians. Collaborative cross-checking occurs when a physician with a fresh perspective assertively challenges assumptions underlying potentially suboptimal diagnoses and treatment plans for complex, unstable patients recently admitted to the intensive care unit.

In this study, three research questions are explored:
1) Do diagnoses change following a patient handoff by attending physicians, resident physicians, nurse practitioners, or nurses in critical care settings?
2) What strategies are employed by critical care providers before, during, and after patient handoffs to increase patient safety?
3) Does change of leadership affect the willingness for interdisciplinary team members to bring up a patient safety concern during rounds?

The primary methodology is targeted ethnographic observations of patient handoffs in two medical intensive care units. Field notes and digital audio-tapes of patient handoffs are collected and analyzed for attending intensivist physicians,
residents physicians, nurse practitioners, and registered nurses. Preliminary findings on collaborative strategies to improve the effectiveness and efficiency of patient handoffs were presented at the 2011 University Otolaryngologists/Otolaryngology Program Directors Organization Meeting in Washington, DC.

**Rapid Response Team Activations as a Burst-like Phenomena: Understanding the Role of Care Team Structure and Designing Solutions**

James Gray, MD  
Beth Israel Deaconess Medical Center  
*NPSF Board Grant*

Rapid response teams (RRT) represent an important approach to improving care quality and reducing preventable harm among hospitalized patients. Our work has demonstrated the value of RRT use in a large academic medical center, yet has uncovered an unexpected increase in the rate of clinical decompensation among other patients following RRT activation in an index patient. We hypothesize that interconnectedness existing between patients due to the sharing of common groups of providers or care teams may play a role in the observed clustering. We propose not a contagion mechanism for this phenomenon but rather a care-team-mediated effect. We will consider as potential contributors to this effect both patient level care team composition as well as the potential that increased focus and attention to one patient during RRT activation may affect the care and alter the sensitivity and specificity of monitoring of others.

We are using information from the Electronic Health Record that is routinely collected during care to identify and characterize care teams and their structure. This use of routinely collected information represents a sustainable approach for ongoing monitoring and analysis of the role of care teams in other types of preventable harm. We are now examining the resulting teams from a network analytic framework in which patients and their connections to other patients and providers constitute the networks of interest.

It is expected that this project will provide specific information to inform assignment patterns for routine care teams as well as the design and implementation of rapid response teams within a system of care with an eye toward reducing preventable harm related to clinical deterioration.

More generally, this project will demonstrate the value of new approaches to exploit the information contained within an electronic health record to enable future investigations into the impact of care team structure on preventable harm.

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**2009–2010**

**Improving Hospital Safety for Children: Strategies to Engage Parents in Bedside Rounds**

Elizabeth Cox, MD, PhD  
University of Wisconsin School of Medicine and Public Health  
*James S. Todd Memorial Award*

The overarching goal of this work is to improve safety for hospitalized children by identifying strategies to address the barriers and facilitators of family engagement in bedside rounds. Each year 7 million U.S. children are hospitalized, which places them at risk for alarming rates of medical error. Engaging families as partners has the potential to improve safety by reducing the likelihood of medication errors and improving hand hygiene to decrease healthcare-associated infections. To facilitate family engagement, experts recommend conducting rounds at the child’s bedside with the family present. To improve safety, family engagement is needed in all three key tasks of the healthcare encounter—building a relationship with the healthcare team, exchanging information, and making decisions about diagnoses, testing, and treatment. Yet, research suggests that engaging families to improve safety meets with reluctance from both healthcare team members and families. Bedside rounds represent a consistent venue to engage families in the care of hospitalized children, yet no studies have systematically identified and addressed barriers and facilitators of family engagement during these rounds as a means to improve safety. This project identified strategies that address common barriers and facilitators of family engagement during bedside rounds using established human factors and systems engineering approaches.

Our data consists of videos of each day of bedside rounds for 30 enrolled families from our inpatient units, resulting in a sample of ~72 bedside rounds videos. Using a stimulated recall technique where families and healthcare team members became the analysts of their own videotaped bedside rounds sessions, participants identified barriers and facilitators of family engagement during rounds, then generated strategies to directly address these. Ultimately, we conducted 39 interviews (17 with parents or children and 22 with healthcare team members) using 24 rounds videos of 20 patients as stimuli. Audiotapes of these stimulated recall sessions were coded using directed content analysis to identify and categorize barriers and facilitators as well as the strategies to address these. The data from
the NPSF project have now been used to further this line of research. Specifically, our comprehensive list of potential strategies has been subjected to a process of proactive risk assessment (PRA) to evaluate the feasibility and potential impact of these strategies on family engagement during rounds. Using this process, stakeholders at our children's hospital have now identified a “best practices” checklist to enhance family engagement in rounds. Once implemented, we will evaluate the impact of this checklist on family engagement and on pediatric patient safety from video and survey data.

Analysis of CPOE-related Errors Reported to USP’s MEDMARX Error Reporting System

Gordon Schiff, MD, and Andrew C. Seger, PharmD
Mary Amato, PharmD, Diana Whitney, Jennifer Boehne, Ali Rashidee, Robert B. Elson, Ross Koppel, David W. Bates
Brigham and Women's Hospital/Harvard Medical School

Drs. Gordon Schiff and Andrew Seger

We analyzed medication errors reported as CPOE-related and conducted in-depth qualitative and quantitative review of a random sample of report narratives to extract insights from the first-hand reports, in order to better understand the nature and mechanism of the reported CPOE-related errors and how better designed systems might have prevented them. Finally we tested the vulnerability of leading CPOE systems to these actual errors by attempting to replicate (on test patients) selected recurring errors identified in the reports, examining these CPOE systems’ susceptibility to (or ability to prevent) such errors.

Of 1.6 million reported errors, 63,040 were reported as CPOE-related. We reviewed and coded 10,000 (15.8%) reports and derived a taxonomy of 73 codes describing error causes, 112 codes describing error effects, and 76 codes describing potential prevention strategies. Leading error causes included multiple electronic systems (1,166 cases), problematic use of abbreviations (489), failure to follow procedures/protocol (468), profiling failure/issues (420), lack of computer training/system knowledge (301), hybrid (electronic and paper) systems (202), entry/typing errors (199), medication reconciliation issues (177), and alerts ignored/overridden (143). Leading error effects included missing/incorrect sig (2,078), missing/wrong quantity ordered (872), wrong dose or strength (849), wrong schedule (548), duplicate orders (474), wrong formulation/dosage form (360), overdose/potential overdose (355), wrong drug (295), and comments field with conflicting information (254). Testing vulnerability of selected CPOE systems to 21 selected prototypical cases found that of 307 attempted erroneous orders, 174 (57%) could be relatively easily replicated (entered easily or with minor workarounds) with no warning or blocking of potentially dangerous orders. Observations of typical users (mostly medical residents) documented multiple instances of error-prone ordering and ignoring of warnings.

Conclusions: Medication error narrative reports are a rich source of descriptions and insights into medication errors, especially those related to CPOE. Review of 10,000 CPOE-related errors provided the foundation for a new taxonomy of errors, and subsequent vulnerability testing revealed that the majority of errors tested could be replicated in current CPOE systems. Selected insights from this analysis include potential for CPOE propagating errors that are perpetuated in recurring orders, potential for facilitation of adjacency/pull down errors, potential for alert fatigue/ignoring with repeated examples of prescribers overriding true positive alerts, and evidence that prescribers often have difficulty entering desired orders leading to potentially dangerous workarounds, in particular description of their intent in free text comments.

Computerized ordering of medications is a priority for improving the safety of medication use, reflecting solid evidence demonstrating its ability to significantly reduce errors. However, unlike any new technology, along with expected benefits come both predictable as well as unanticipated consequences. In addition to the spread of CPOE over the past decade there have been considerable patient safety efforts invested in developing systems for medical and medication error reporting. One of these initiatives has been the United States Pharmacopeia (USP) MEDMARX medication error reporting system (now owned and administered by QUANTROS) which has collected more than 2 million medication errors from more than 800 hospitals and health systems. Beginning in 2003 MEDMARX added “Computerized Prescriber Order Entry as a Cause of the Error” as one of the variables in their error reporting tool. The number of CPOE-related reports in the database has now grown to more than 50,000. Our project conducted an in-depth analysis of these reports by an experienced team of patient safety pharmacists and physician researchers.
Identifying the Cognitive Dimensions of ‘Failure to Rescue’

Alexa Doig, PhD, RN  
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NPSF Board Grant

Training programs designed to enhance nurse performance in areas affecting patient safety must be based on a thorough understanding of the cognitive psychology of the nurse. The purpose of this research is to identify the cognitive patterns that help nurses successfully detect life threatening complications versus those that consistently lead to missed opportunity or ‘failure to rescue’. In this study we observed novice and experienced oncology nurses as they monitored hospitalized cancer patients in a high-fidelity simulated environment. Following the observations, video-based debriefing interviews were used to capture the thought processes underlying observed behaviors. The goal of the analysis was to compare and contrast observed behaviors and thought processes among successfully detected events and potential failure-to-rescue situations.

Successful and unsuccessful strategies used for patient surveillance and heuristics used as the basis for clinical decision making are being examined. Preliminary findings are that use of electronic medical record data (patient history and laboratory results) and information regarding physiological trends in patient state are related to the successful detection of early sepsis. Amount or type of data acquired during the physical assessment, including current vital signs, is not a factor determining failure to rescue.

Based on the findings from this study, we will develop and evaluate a cognitive training intervention to help novice oncology nurses rapidly acquire expertise in the surveillance for and detection of life threatening complications. With this refined method for clinical training we hope to promote early detection and recognition of situations that have a high potential of leading to failure to rescue.

Improving Patient Trajectory Management and Care Coordination with a Multidisciplinary Checklist

Ayse P. Gurses, PhD, Peter Pronovost, MD, PhD, Priyadarshini Pennathur, PhD, and Yan Xiao, PhD, Armstrong Institute for Patient Safety and Quality, Department of Anesthesiology and Critical Care Medicine, Johns Hopkins University

James S. Todd Memorial Award

The first objective of this project was to identify barriers to and principles and strategies for effective care coordination and patient trajectory management. A trajectory is a sequence of actions toward a goal (e.g., safe patient discharge) including any contingencies and interactions among care providers, patients and families. Effective patient trajectory management is essential for improving patient safety and reducing costs of care. Human factors and cognitive systems engineering can provide a strong theoretical framework for developing the practices and tools needed to improve coordination and trajectory management.

We have been conducting ethnographic studies (direct observations during rounds and handoff reports as well as semistructured interviews) in two different sites. Preliminary results indicate that there are several barriers to effective trajectory management such as ineffective and inadequate communication among multidisciplinary care providers, inadequate and misleading communication with patients and families regarding discharge planning, ambiguity regarding when to pass the baton to the primary care provider, problems in medication reconciliation due to multiple and poorly designed information systems, and delays in writing medical orders necessary to start the home care and rehabilitation arrangements. Based on the preliminary findings, we designed and pilot tested a paper-based daily communication tool that provides an overview of each patient’s trajectory, including anticipated discharge date and location, major milestones, goals, and possible threats to a safe and timely discharge, teaching needs, other tasks-to-do, future plans, and assignment of responsibility.

The second objective was to characterize communication among multidisciplinary care providers during discharge rounds. Based on the qualitative analysis driven by data collected through audio-recording of 20 discharge rounds, we argue that the content of communication during discharge rounds could be described by three categories: (1) patient’s
status on the trajectory (e.g., demographics, clinical condition, etc.); (2) deviations from/ complications on the trajectory (e.g., social and family issues, deviations due to clinical complications, etc.); and (3) anticipating possible trajectories and plans for the rest of the trajectory (e.g., discharge time, milestones for discharge, etc.). In addition, based on the detailed analysis of the “structure of communication,” we found that providers may follow a certain structure or order during discharge communication. For instance, they switch to categories previously discussed for a patient in the same discharge meeting, perhaps due to questions and discussion prompting repetition of information. The beginning of the discharge communication usually reflects anchors to identify the patient and understand their current status, whereas the end part of the communication is typically a summary of what the outcome of the discharge communication is. Although there is evidence of more open-ended discussion, these discussions are not heavily focused on the deviations on the patient’s trajectory, as these may be set for offline discussion due to time limitations. We believe that partial computerization of details that can be more concisely communicated or through written form will provide more team time for discussing pertinent information such as clinical deviations and may help facilitate effective discharge communication and a timely discharge. Our insights from this analysis indicate that future design of information technologies needs to facilitate efficiency in communicating status information, and enhance providers’ awareness of the patient trajectory for an effective discharge communication.

The project has major implications as it will lay the foundation for identifying practices and developing tools to improve coordination and safety in multidisciplinary care environments. Furthermore, this initial study was pivotal in allowing Dr. Ayse P. Gurses to obtain a Career Grant (K01) from the Agency for Healthcare Research and Quality aimed at improving the safety of care transitions (from operating room to ICU, ICU to floor, and during the discharge planning process).

2007–2008

Knowledge Discovery: The Development of an Error/Solution Matrix to Improve Patient Safety
Harold S. Kaplan, MD, and Barbara Rabin Fastman
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NPSF Board Grant

The overarching goal of this research project was to turn medical event data into information and actionable solution knowledge. We hypothesized that information embedded in medical event report narratives represents an untapped source of solutions to human and system failures, and that analysis of these narratives can contribute to the development of a new taxonomy of solutions. An error/solution matrix could then be developed that would aid in formulating solutions based on event characteristics.

Recovery, mitigation, and corrective action data from a set of near-miss and no-harm medical event reports were analyzed. The majority of “solutions” found in the narratives were either expected (e.g.: be more careful, follow the protocol), or specific to a certain event (with its associated contextual nuances), and would have resulted in solution categories neither novel nor ultimately useful. Solution taxonomies from fields outside of healthcare were then studied, but no single existing typology from industry was found to be optimal for classifying potential solutions for use with medical events. We needed to create a new taxonomy that would combine what we had learned from both medical event reports and other industries.

Three sub-taxonomies were developed: (1) problem descriptors (e.g.: incorrect, confusing, damaged), (2) the condition involved (e.g.: action, item, policy), and (3) solutions and their subsets (e.g.: make obvious, simplify, automate). These sub-taxonomies were then linked in matrices and tested against medical event data.

We are continuing the evaluation and evolution of the matrix, and adding solutions as we mine the data. Although very useful as it currently exists, preliminary data suggests that the matrix may be simplified or further revised. We are also testing a preliminary method to computerize the matrices for ease of use. The utility and potential impact of this work will be determined by how effectively it strengthens the weakest link in the healthcare problem-solving paradigm – the generation of optimal solutions.
Interruptions in the Emergency Room

Nancy Franklin, PhD, Benjamin Swets, PhD, and Asa (Peter) Viccellio, MD
Stony Brook University

James S. Todd Memorial Award

Drs. Nancy Franklin, Peter Viccellio, and Benjamin Swets

ER physicians typically juggle several tasks at once and are required to wait for test results, colleagues, and other resources whose availability is unpredictable. Traditional research in both medicine and cognitive psychology suggests that performance in such an environment should benefit from a total elimination of interruption. We approached our research from quite a different view, by focusing on how interruptions might serve as optimally-timed reminders to return to previously suspended tasks.

Our initial work involved observing ER physicians during their shift at a large teaching hospital. We found interruptions to be frequent and typically relevant to cases under the physician’s care. Senior physicians were interrupted about 40% more often than junior physicians, and interruptions were far more likely to be relevant to temporarily suspended cases for the senior than junior physicians. Given the higher caseload of senior physicians, these findings suggest that interruptions may play a valuable role in optimizing performance.

Following on this finding, we completed four experiments that required participants to perform a demanding video simulation task that allowed us to both experimentally manipulate factors relevant to interruption and record participants’ actions in great detail. Undergraduates or physicians were to collect a large amount of information over time as either mock detectives (undergraduate version) or ER doctors (physician version). Each simulation required maintaining and integrating information for three separate cases, noting relationships among elements, and detecting occasional contradictions. Participants were required up to 45 times to temporarily suspend their current activity and to remember to collect information items upon their return. In all studies, some participants were interrupted when information became available, and others were not.

Consistent with our ER observations, our experimental data demonstrated that interruptions calling people back to a previously suspended task at the appropriate time can greatly facilitate performance. Interrupted participants were more likely to successfully collect critical information and were much more efficient in progressing through the simulation. (Interestingly, those scoring lowest on tests of working memory actually benefited the most from such interruptions, suggesting that as case-load increases or as fatigue sets in toward the end of an ER shift, interruption may become even more effective.) Furthermore, global comprehension scores, including higher-order inferences and detection of contradictions, increased for participants who had been interrupted.

We found one consistent cost of interruptions, for both participants groups. Local resumption of a previously interrupted task is often inefficient, requiring some back-tracking and fumbling around. (This is consistent with the deleterious effects of irrelevant interruptions that have been studied extensively in the literature.) But our larger set of findings concerning relevant interruptions strongly suggests that we shouldn’t eliminate or even drastically reduce them in demanding work environments like the ER.

The support from NPSF has allowed us to develop a complex, flexible analogue to cognitively taxing work environments. This tool will provide much greater experimental sensitivity for investigating a problem that impacts not just the ER, but also other demanding healthcare and professional settings.

2006–2007

Patient Safety in After Hours Telephone Medicine

Shersten Killip
University of Kentucky Department of Family and Community Medicine

The overall objective of this study is to explore the nature and extent of errors in telephone medicine encounters between physicians and patients. There are over 50 million after hours telephone encounters per year in the United States. This qualitative study is intended to determine the incidence and types of errors and/or threats to patient safety which result from after-hours telephone medicine. Using interviews with patients, the researchers intend to generate the first detailed taxonomy of errors in after-hours telephone medicine, and the first large-scale report of the harms and potential harms related to telephone medicine.
Understanding Medical Errors in Hospital Psychiatry

Steven Marcus, PhD, and Richard Hermann, MD
University of Pennsylvania School of Social Policy & Practice

James S. Todd Memorial Award

There are over one million discharges from inpatient psychiatric units of acute care hospitals annually, yet knowledge about critical patient-safety events is notably deficient for mental health care settings because major studies on the topic have systematically excluded patients with mental disorders. Our award from the National Patient Safety Foundation has allowed us to begin to characterize patient safety events in inpatient mental health care by: 1) designing a medical record screening form to detect potential adverse incidents that occur on psychiatric inpatient units, 2) having a team of medical records administrators use that form to screen all discharges for one year from the inpatient psychiatric units at two urban medical centers, 3) assessing the reliability and feasibility of the screening form and making changes to it based on the review process, 4) using the revised screening form to review one year of discharges from both hospitals, 5) designing and testing an extensive physician review form to measure the incidence, nature, and preventability of inpatient psychiatric incidents, 6) using this physician review form to carefully examine a large sample of charts screened positive by the medical records administrators, and 7) assessing the reliability and feasibility of the physician review form and making changes to it based on the review process. Our results indicate that patient safety events are common in psychiatric inpatient settings, that they differ from those found in general medicine/surgery, and that the patient safety event rates vary by hospital. When events occur, they cause harm and are often the result of error, but are largely preventable. We used the tools and results of this pilot work as the foundation for a recently awarded R01 from the National Institute of Mental Health to examine the patient, provider, and psychiatric unit factors associated with the incidence, nature and preventability of patient safety events occurring in a large random sample of patients from Pennsylvania inpatient psychiatric units of general hospitals. Our goal is to build prevention strategies for inpatient mental health care that enhance the provision of safe clinical care for this vulnerable patient population.

2005–2006

Developing a Knowledge Base for RN Stacking: A Critical Patient Safety Strategy for Nursing Care Delivery

Patricia Ebright, DNS, RN
Indiana University School of Nursing

Preliminary research by this research team identified a critical safety-related aspect of registered nurse (RN) work not previously addressed in the literature, nor taught in schools of nursing. Called “stacking,” it is a workload management strategy for adapting and coping with the demands of workplace variability and complexity. Increased understanding of stacking has the potential to affect the education and care delivery of this bolus of neophytes likely to be swelling the ranks of nursing over the next few years.

A first step to reaching that goal is to increase our understanding of the phenomenon of stacking and to identify critical attributes of stacking management that lead to safe delivery of patient care. The specific aims of our study were to explore the following questions to develop a knowledge base about stacking.

- What activities are stacked by RNs in the context of real-life care situations?
- What factors, including goals and constraints, contribute to RN decisions surrounding what to stack and stacking strategies?
- What strategies do RNs use to manage the stack, particularly those that reduce the potential for and consequences from erroneous actions, unexpected situations and complicating factors?

Multiple methods of data collection including direct observation and critical task analysis interviews were used to capture rich data about RN stacking experiences to begin building a useful knowledge base. Four types of primary findings resulted from the study: 1) factors that increase the complexity of RN decision making about care delivery; 2) eight decisions RNs make about the prioritization and management of multiple competing activities in their work; 3) RN work activity hierarchy based on prioritization in workflow; and, 4) new RN graduate differences from experienced RNs on management and prioritization effectiveness of competing care activities. Findings from this research have been presented multiple times over the last several years to researchers, educators, and healthcare professionals.
administrators interested in the actual work of RN care providers, including a poster presentation at the NPSF Congress in 2009. Two web-based teaching modules for nurse educators, based on findings from this study, are included in Quality and Safety Education for Nurses (QSEN). The concept RN Stacking is also being included in a manuscript on the proposed framework for the cognitive work of nursing in actual care delivery to be submitted in 2010.

Co-investigators on the project were: Emily Patterson, PhD, Jason Saleem, PhD, Richard Frankel, PhD, and Bradley Doebbeling, MD.

Automated Maintenance of Problem-Drug Matches in the Electronic Medical Record to Promote Patient Safety

Chiang S. Jao, PhD
University of Illinois/National Library of Medicine

The advent of electronic medical records (EMRs) with computerized physician order entry (CPOE) makes real time clinical decision support systems (CDSSs) feasible. We had tested the hypothesis that a CDSS that automates the matching of ordered drugs to problems on the problem list can enhance the maintenance of both the drug list and the problem list. Enhanced maintenance of both the drug and problem lists can permit the exploitation of advanced decision support strategies that will yield higher patient safety. We designed a standalone decision support tool whose rules are automatically fired to match drugs ordered to problems on the problem list. We tested this tool on 100 preliminary cases and then assessed the performance of this decision support tool on 140 additional cases. The rules developed in this research have been successfully transplanted into an embedded decision support system plugged into the EMR-CPOE system of the University of Illinois Hospital.

The support from NPSF assisted the fulfillment of a practical decision support tool in the maintenance of medication-problem reconciliation with the EMR system. I am currently working as Chief Biomedical Informaticist in a biotechnology firm after a one-year visit in the National Library of Medicine to extend my research interest in reducing medication errors. Medications represent a major source of potential harm to patients. Adverse drug events (ADEs) remain widespread and negatively affect the quality and efficiency of patient care. My current focus is to detect ADEs in personal health records using available tools in medical ontologies and CDSS. The results open a potential that this approach can achieve toward automatic ADE detection.

As of 2012, Dr. Jao is with Tranformation Inc. based in Maryland.

Post-Surgical Patients Receiving Patient Controlled Analgesia (PCA)

Frank J. Overdyk, MD
Medical University of South Carolina

This study investigates the incidence and etiology of respiratory compromise in post-surgical patients receiving patient-controlled analgesia (PCA). It seeks to quantify and stratify the risks of this therapy, and develop prognostic algorithms that may be incorporated into PCA pump alarm systems. Respiratory compromise during PCA may be transient or progress to respiratory arrest unless diagnosed and treated in a timely manner. This study will use a new technology, PCA pumps with integrated, telemetric, oximetry and capnometry modules, to continuously measure respiratory parameters of post-surgical patients. The only clinical site worldwide that has this equipment currently implemented is the venue for this study. Although well described in the operating room and procedural suites, this monitoring combination has never been applied to patients receiving PCA. The respiratory data collected, synchronized with postoperative clinical events, will allow the incidence of respiratory compromise to be measured and characterize the respiratory and heart rate patterns that precede these events. Analysis of pilot study data suggests that heuristic pattern recognition algorithms may be developed that will predict impending respiratory compromise and aid in the determination of its causes. A multidisciplinary research team with expertise in pain management, pharmacology, statistics, respiratory therapy, medical informatics, biomedical engineering and anesthesiology has been assembled to accomplish the objectives of the study. This study will quantify the risk and improve the safety of PCA, and provide new insights into the respiratory pathophysiology associated with acute post-surgical pain and its treatment.

2004–2005

Community Based Patient Safety Education for the Elderly

Nancy C. Elder, MD, MSPH
University of Cincinnati Department of Family and Community Medicine

Historically, most research on patient safety has occurred in the hospital setting, yet most health care is provided in the outpatient, office-based setting. Our research with primary care patients revealed that experiencing problems and errors during
health care frequently led to the adoption of safety-enhancing and advocacy behaviors. It was our desire to assist patients in making these changes without experiencing such events, in order to prevent their likelihood of occurring or, if errors occur, to decrease their likelihood of leading to harm. Our study trained elderly people, who are at increased risk of experiencing error from their office-based care, to serve as their own safety advocates for care.

Using a newly developed instrument, the Seniors Empowerment and Advocacy for Patient Safety (SEAPS) survey, we assessed behaviors, self-efficacy, outcome efficacy and attitudes toward recommended patient-based safety activities both before and after a two-part educational intervention. The intervention was comprised of an interactive group session and an individual training session using the PACE (Present, Ask, Check and Express) communication system. The intervention was successful in improving participants’ mean total SEAPS scores.

All demographic groups (sex, race, education, and frequency of doctor visits) showed significant improvement except for those with more than a high school education. All participants acknowledged learning new skills and ideas, as well as new ways of organizing their own health care information. Although intensive in effort, this pilot intervention demonstrated that elderly patients can improve their beliefs and self-reported safety behaviors in the ambulatory setting.

**Improve Patients’ Safety: Learning Model to Reduce Errors in Occupational Therapy and Physical Therapy Practice**

**Keli Mu, PhD, OTR/L**

**Creighton University**

**James S. Todd Memorial Award**

This two-year grant project is an interprofessional endeavor that aims at understanding the phenomenon of practice errors in occupational therapy and physical therapy; exploring preventive strategies; and developing a learning model and disseminating educational materials in an effort to improve patient safety. Using quantitative and qualitative research methods, this project draws upon professional expertise from various professions including OT, PT and bioethics to investigate preventive strategies and develop learning modules for error reduction.

Results of the project reveal that “to err is human”—occupational therapists and physical therapists make errors in their practice. Causes of errors vary considerably and include both individual and systemic factors. Although errors are inevitable, various discrete and specific strategies can be implemented to help significantly prevent, reduce or even eliminate practice errors and improve safety. Such strategies consist of: (1) strengthen orientation and mentoring to new therapists; (2) ensure competency through performance competency checks; (3) establish new or capitalize on existing safety policies and procedures; (4) advocate for the profession and systematic change.

Research literature on practice errors and patient safety is very scarce currently in occupational therapy and physical therapy. Findings of this project greatly contribute to the body of knowledge on patient safety in occupational therapy and physical therapy. Occupational therapists, physical therapists and other health care providers can implement specific strategies found in this project to prevent/reduce practice errors and ultimately improve patient safety.
sedated, the procedure performed, and the provider who performed the sedation, as well as data on the safety and effectiveness of the care that was provided.

The initial data analysis from the group has concentrated on defining the common safety concerns involved in the field of pediatric sedation—regardless of the specialty of the sedation provider. Other work is continuing on comparison studies of the effectiveness and safety of the different drugs used by members of the consortium. Still other investigators within the consortium are trying to use the database to answer questions on “hot-button” sedation issues such as the safety of propofol use by practitioners other than anesthesiologists.

The ultimate goal of the consortium is to use the power of this very large database to highlight and promote “best practice” that meets the highest standards of safety and effectiveness in the field of pediatric sedation. We are also hoping to use the information from this study to formulate collaborative multicenter trials. This project remains a unique example of the power of a collaborative effort among a wide array of specialists with the single goal—that of improving the safety and quality of care delivery in a particular field of practice.

Can Knowledge from a Clinical Decision Support System Developed at an Academic Medical Center Be Applied to Other Hospitals and Populations Throughout an Integrated Delivery Network?

Martha J. Radford, MD
Yale New Haven Health

Co-sponsored by NPSF and the Donaghue Foundation

We strove to understand consequences of automated decision support for medication safety in one of our three system hospitals, in order to apply this knowledge at the other two hospitals, where different electronic health records were deployed. We analyzed both quantitatively and qualitatively all medication misadventures reported at one hospital, and communicated them with the other two hospitals. The following insights were generalizable and actionable across hospitals:

• Identification of general themes concerning medication safety: which medications were particularly problematic; where in the medication administration chain (preparation; distribution; dispensing; monitoring) were problems occurring.

• Workflow innovations that did not involve the specific electronic health record (responsibility for various steps in the medication administration chain; medication monitoring routines, etc.).

By contrast, issues that involved technical solutions, for example, specific programming for specific decision support modules, needed to be customized to each hospital’s electronic health record.

2002–2003

A Clinical Decision Support Tool to Improve Quality of Transition Care: Pilot Trial of Process

James O. Judge, MD
Connecticut VNA CDS Study Team

Co-sponsored by NPSF and the Donaghue Foundation

Improving the accurate flow of information in transitions of care is a critical quality issue for older patients with multiple conditions. This pilot study tested one strategy of improving the quality and timeliness of information flow to the Primary Care Physician following a hospital stay (with or without a stay in a post acute facility). Intake nurses requested key laboratory results in addition to medical diagnoses and medication. Following the initial reconciliation process for medications, a consulting pharmacist entered the laboratory data and medications and diagnoses into geriatrics clinical decision support (CDS) system- 55 algorithms that assessed for choice and dosage of medications, medication interactions, and need for laboratory follow-up. Following editing by the consultant pharmacist for redundancy, the Primary Care Physician received a fax containing the reconciled medication list, diagnoses, lab results, and CDS messages, with a request that they respond by phone or fax.

Hospitals and Post Acute centers provided key laboratory data on 170 of the 206 patients. The CDS system generated 630 messages that might warrant action by the physician- a median of 3 messages per patient. 282 messages suggested a modification in the medication regimen (179 messages to change or D/C drug. 103 messages to add a medication). 325 messages suggested a follow-up laboratory test. In addition, 303 messages suggesting close monitoring were generated, but required action primarily by the home care nurses. Physicians initiated 90 actions in response to the messages—45 medication changes (16% response rate) and 50 lab tests ordered (15% response rate).

A key process measure—providing the Primary Care Physician with key laboratory results at the initiation of home care—was achieved for 84% of the patients. The Clinical Decision Support tool generated a median of 3 messages that might warrant action by the primary care physician at the start of home care following a non elective hospital admission. These messages were in addition to the usual initial medication reconciliation process.

The relatively low response rate to CDS suggestions suggests either that refinement in the CDS messaging and in methods of communicating to the Primary Care Physician is needed or that Clinical Decision Support tools, no matter how well designed, will serve only as warning flags for physician consideration.
Talking to Patients About Medical Errors
Kathleen M. Mazor, EdD
University of Massachusetts Medical School
Co-sponsored by NPSF and The Commonwealth Fund

When medical errors do occur, effective physician-patient communication is critical. Prompt and candid disclosure of errors is important not only for the patients, families and providers involved, but also for the wider medical community—open discussion of error is prerequisite to the identification of causes of error, and subsequent improvements to the health care system. Such discussions cannot occur without including patients and families. In spite of its importance, there has been little empirical work on disclosure of medical errors. This study brought a patient-focused, evidence-based approach to discussions of disclosure of medical error.

To better understand patients’ views, we developed a series of video-vignettes. Each vignette described a medical error, and portrayed a physician talking with a patient about the error. The video-vignettes varied in type of medication error, level of disclosure, reference to a prior positive physician-patient relationship, an offer to waive costs, and clinical outcome. After viewing a video, participants reported how they would feel if they were the patient or family member involved. Dependent measures included patient satisfaction, trust, emotional response, likelihood of changing physicians, and likelihood of seeking legal advice. Results led us to conclude that full disclosure is likely to have a positive effect or no effect on how patients respond to medical errors. The clinical outcome also influences patients’ responses. The impact of an existing positive physician-patient relationship, or of waiving costs associated with the error, remains uncertain.

The paper reporting findings from this study was published in the Journal of General Internal Medicine. Dr. Mazor and her team have continued to work in this area. She recently completed a study of parents’ views on medical errors, which has been published in the Journal of Patient Safety.

Role of Patient and Clinician Champions as Safety Advocates in Adult Ambulatory Multidisciplinary Practice Settings
Patricia Reid Ponte, RN, DNSc, and Barbara E. Bierer, MD
Dana-Farber Cancer Institute

Dana-Farber Cancer Institute (DFCI) studied enhancements to their patient safety rounds program in 2003 and 2004. The study compared and evaluated two models for patient safety rounds. In one model, investigators introduced a clinician champion for patient safety to an ambulatory chemotherapy infusion unit. In the other model, investigators introduced patient/family safety liaisons—patient and family volunteers who elicited reports from patients receiving treatment on another ambulatory infusion unit. Investigators measured the number, type, and severity of reports elicited before and after introduction of the clinician champion, and compared reports elicited from staff with those elicited from patients. Investigators also developed a toolkit of materials that could assist other organizations to institute the Dana-Farber patient safety rounds model.

Preliminary findings showed that introduction of a clinician champion coincided with a substantial increase in the reporting rate on the intervention unit. However, staff reporting throughout the organization increased during the same period, so it was difficult to attribute the increased rate to the clinician champion alone. In terms of the patient/family liaison intervention, patients reported high staff compliance with safe practices such as identity checking. Although one in five patients reported that they experienced an “unsafe” experience, no serious adverse events were reported. The types of reports elicited via staff reports differed from those elicited from patients. Staff reports focused on problems related to medications and laboratory results; patient reports included issues with communication and the physical environment.

The project has received attention by senior organization officials and members of the board of trustees, and results have been shared in several national forums. The final toolkit was released in June 2006. Although the organization did not continue to use the model of patient/family liaison in patient safety rounding, patients and families continue to play an integral role in the patient safety programs at DFCI.

Transitions in Care: Signovers in the ED
Shawna Perry, MD
University of Florida
Co-sponsored by NPSF, the James S. Todd Memorial Award, and the Donaghue Foundation

The need for continuous 24-hour care in the emergency department (ED) requires nurses and physicians to transfer patients to a new group of caregivers at the end of a shift. These transitions are critically important to the quality and safety of ED care but have received little attention.

Authority, responsibility, and information are all transferred through a process of co-construction in which both the oncoming and the offgoing parties are active participants.

To date, attempts to improve handovers in the ED have generally failed. This study demonstrated that this failure may in part be due to a lack of deep understanding of the multidimensional nature of transitions—resulting in a one-size-fits-all approach that does not support medical dynamics.

The researchers on this team propose a conceptual framework to characterize signovers which may help clarify future studies and assist in crafting interventions to better fit the context of clinical work.
Remote Analysis of Team Environments: Measuring the Effect of Debriefing Attendings on Surgical Safety Factors

Reid B. Adams, MD, James Forrest Calland, MD, and Stephanie Guerlain, PhD, University of Virginia

The investigators of this study utilized an institutionally developed, integrated, multi-media audio-visual and sensor data collection system (RATE, for Remote Analysis of Team Environments). Debriefing sessions, which followed evaluation of baseline team performance and Crew Resource Management (CRM)* training sessions, were held with the attending surgeon and his team after the surgical procedure and included discussion and critique using video clips of the operative case.

Preoperative briefing elements and optimal intra-operative communication practices increased in frequency after implementation of CRM training and debriefing sessions, and this effect was sustained over subsequent study cases for each surgical team. Case specific participant knowledge and awareness, evaluated from post case questionnaires, also improved after debriefing sessions.

This study demonstrated that debriefing sessions are an effective technique to positively influence surgical safety factors of attending surgeons and their team members.

*The CRM presentation was based on materials prepared by the Medical Team Management Department of the US Air Force.

Assessing Hospitals’ Use of Mandatory Error Reports for Quality Improvement and Error Reduction

Kimberley Fox, MPA, and Joel C. Cantor, ScD
Center for State Health Policy, Rutgers University

James S. Todd Memorial Award

State-mandated medical error reporting in hospitals and other health care facilities has become common since the release of the Institute of Medicine’s report To Err is Human in 2000. In 2002, Rutgers Center for State Health Policy conducted an exploratory study funded by the National Patient Safety Foundation to assess hospitals’ use of mandatory medical error and adverse event reports in New York State. This system, called New York Patient Occurrence Reporting and Tracking System (NYPORTS), is one of the oldest and largest state-mandated hospital reporting systems in the country. Based on semi-structured telephone interviews with over 100 administrative and clinical leaders from a stratified random sample of 20 hospitals throughout New York State, the study investigated hospital leaders’ awareness and perceived purpose of the reporting system, the process by which hospitals collect and use this data, the barriers to use, and perceived value by hospital leaders and its impact on patient safety. The study also sought to identify key factors that either facilitated or limited the use of data from the mandatory reporting system within New York State hospitals.

This study, the first of its kind, found that state-mandated hospital adverse event reporting in New York was successful in raising awareness of patient safety among hospital leadership and promoting investigative processes of serious medical errors that hospitals have found to be useful. However, during the early years of the reporting system, hospitals did not appear to have been utilizing much of NYPORTS adverse event data because of insufficient comparative data feedback and lack of confidence in event reporting across hospitals. We generally did not observe variations in patterns of use across hospital types. Our primary findings instead demonstrate the influence that one’s position in a hospital’s administrative and leadership structure has for perceptions of this adverse event reporting system. This study suggests that well-designed, state-mandated reporting systems can have positive impacts in raising awareness and accountability within hospitals, but also points to some barriers and burdens that designers of next-generation error reporting systems should address.

Impact of Computerized Alerts and Reminders on Implementation of a Weight Based Unfractionated Heparin Dosing Protocol

Ann Marie Greco, PharmD, and Maryam Behta, PharmD
New York-Presbyterian Hospital

At New York-Presbyterian Hospital (NYPH), we have implemented, and are in the process of evaluating, an IT-based project to improve the management of patients receiving heparin therapy. The project is designed to assure that care at NYPH is compliant with nationally accepted weight-based heparin dosing guidelines.

NYPH is a 2400-bed multi-campus academic health center. NYPH has an Eclipsys Computerized Provider Order Entry (CPOE) system implemented throughout the hospital. For this project, we are taking advantage of the clinical decision support features available in Eclipsys.
Data about heparin orders, administrations and other medications will be extracted from Eclipsys. PTT and creatinine results to assess exclusion criteria will be extracted from the lab system. Information about co-morbid conditions and adverse outcomes will come from chart review and the administrative data warehouse.

We have completed designing the experimental and analytic plan. We have also completed several interventions and designed measurement system analysis to evaluate and ensure data integrity. We are currently moving forward with the data collection using these refined automated and manual data collection methodologies.

2000–2001

Diagnostic Errors in Internal Medicine
Mark Graber, MD, FACP
Department of Veterans Affairs

James S. Todd Memorial Award

This project sought to better understand the root causes of diagnostic errors encountered in internal medicine. To conduct the study, one hundred cases of diagnostic error were identified from autopsy discrepancies, quality assurance activities, and voluntary reports. Contributing factors were identified by root cause analysis with the help of a cognitive psychologist. We modified several existing taxonomies to develop one that was useful in categorizing the contributing factors, grouped under System-Related, Cognitive, or No Fault categories.

Seven cases exclusively involved “no fault” errors. Of the other 93 cases, 548 different system- or cognition-related errors were found, with an average of 6 system- or cognition-related errors per case. System errors contributed to the diagnostic error in 65% of the 100 cases; cognitive errors contributed in 74% of the errors. The most common system-related errors involved problems with policies and procedures, inefficient processes, teamwork, and communication. The most common cognitive problems involved faulty synthesis of the available information, most often related to premature closure, context errors, anchoring, and other issues. Faulty or inadequate knowledge was the least common error.

The study contributed one of the first good working definitions of diagnostic error and a useful taxonomy. The finding that most errors involve both system and cognitive elements was somewhat of a surprise, and points out the need for healthcare institutions to focus on this problem as a systems issue. The detailed analysis of each case, including interviews with the responsible staff, also offered unique insights into the origins of these errors, details that are typically lacking in many retrospective error reviews.

This work, completed in 2004, and further discussions of diagnostic error have also served to bring together a growing number of clinicians and other stakeholders concerned about this problem. An outgrowth of this (2008) has been an annual international meeting, Diagnostic Error in Medicine, dedicated to the topic of diagnostic error. More recently, the growing community of stakeholders interested in making diagnosis more reliable and safe has constituted a new Society to Improve Diagnosis in Medicine (www.improvediagnosis.org).

Dedicated Medication Nurses and Medication Errors
Nancy Greengold, MD, MBA
Cedars-Sinai Health System

The goal of this study was to determine whether the provision of a dedicated, specially trained medication nurse would reduce the number of medication administration errors in the hospital setting. The study was performed at two large hospitals. At both institutions combined, medication nurses had a 15.7% error rate compared to 14.9% for general nurses (P<.84). Based on this randomized trial, it appears that the use of dedicated medication nurses does not reduce medication error rates. Instead, this study suggests that medication errors are usually related to systems design issues.

Dr. Greengold is now heading up a commercial business unit called the Zynx Health Device Network, which has just launched a new patient-safety solution called Prime-A-Pump. This customizable Web-based program offers clinical decision support to help hospitals build the “drug libraries” that are used to configure “smart” infusion pumps. Zynx provides the evidence-based and expert-based recommendations for how to set the soft and hard minimum and maximum limits/alerts in these pumps to try to prevent under- and over-dosing errors at the nurse administration stage of medication delivery.
The Surgeon’s Checklist
R. Scott Jones, MD, and J. Forrest Calland, MD
University of Virginia

Based on the successful use of checklists developed in aviation and anesthesia practices, the investigators of this study developed and evaluated an intra-operative safety checklist to reduce the frequency of procedural variance, adverse events, and errors in the operating room.

The use of the checklist led to a significant improvement in the frequency with which surgical teams conducted a pre-procedure briefing, but decreased the team members’ satisfaction with communication. Participant questionnaires revealed that group situational awareness was not significantly better among checklist participants. Furthermore, there was not a significant difference between intervention and control group surgeons’ technical proficiency. This study brings into question the utility of checklists without supplemental communications training or debriefing of the operative team.

Understanding Errors in Emergency Departments: A Convergence Approach
Robert L. Wears, MD, MS, PhD
University of Florida and University of Michigan

This study sought to develop an understanding of the nature and mechanisms of errors in Emergency Departments (ED). Building on previous research that addressed the type and scope of errors in ED, this research team looked to answer “why” and “how” those failures occur. The study was carried out in two academic emergency department sites at the investigators’ home institutions, the University of Florida (UF) and the University of Michigan (UM).

Four different methods of data collection were used: direct ethnographic observations of both routine ED work and critical incidents or adverse events; voluntary, anonymous reporting of incidents and unsafe conditions; semi-structured interviews of ED staff at all levels; and a survey of safety-related attitudes. The final analysis was undertaken after all the observational efforts were completed. This involved both qualitative and quantitative analytic methods. This study has led to several publications as well as several national and international presentations. Through this work, the research team determined that implications for patient safety in ED care can be expressed as a series of dilemmas, or tradeoffs that must be negotiated. The abundant negotiation at many levels gives an opportunity to develop methods of inter-relating more heedfully—or it could result in a normalization of deviance, as parties implicitly agree to ignore aberrancies and drift toward the limits of safe practice. Similarly, enriching communication channels could improve the transfer of information and the development of shared mental models—or it could add to the information overload already experienced by caregivers. Finally, the demand/resource mismatch seems to be an opportune target for improvement—but risks becoming the main focus of attention, or a self-serving suboptimization.

Perhaps the most important outcome from the project has been the improvement in the team’s ability to attract additional research funding to continue investigation in this area. The information gained through this process will improve basic understanding of how success and failure occur in the ED. An immediately applicable outcome will be an extension of existing frameworks for analysis of critical events.

Our initial NPSF project, aimed at understanding how clinicians make sense of and manage risk in the emergency department, was a transformational experience: it introduced our team to issues of complexity, sense-making, resilience, and above all the situatedness of work that we had previously been unaware of, and changed the direction of all of our subsequent research efforts. It has led to further funded work on communication, turnovers, problem recognition, and resilience in complex, uncertain, demanding, high-risk settings.

Update 2012: The project is leading to a book-length exploration of safety in emergency care (tentatively titled “Risk and Resilience”). The book has taken a slight detour as it led to the development of a PhD thesis; the PhD was just granted by the Crisis and Risk Research Centre at Ecoles des Mines de Paris, under the supervision of Erik Hollnagel. So now I am able to turn back to the book itself.

The NPSF project, and the team it enabled us to assemble, has carried on additional work, notably a multi-institution study of shift change turnovers that has expanded to other transitions of care. In addition, Prof. Kathleen Sutcliffe and I have received a Robert Wood Johnson Foundation Investigator Award to study the evolution of patient safety as a social movement; this will lead to a book, tentatively entitled “Medicalizing Patient Safety,” although we are still in the data gathering phase of this work. In addition, Steve Schenkel (one of the recruited participants in the NPSF project) and I have co-edited a well-received text Patient Safety in Emergency Medicine.

We have also done additional research on the effect of HIT on patient safety, developing a guide for assessing the safety of IT during its operation and maintenance, and are participating in a study of root cause analyses and their recommendations for action.

Finally, I have been named chair of AHRQ’s study section on safety and quality, and joined the board of directors of the Emergency Medicine Patient Safety Foundation in 2010.
1999–2000

Pediatric Sedation: A Safety and Efficacy Problem in Children Requiring Diagnostic and Therapeutic Procedures in the Hospital Setting: A Human Factors Opportunity for Improvement

George Blike, MD
Hitchcock Foundation, Dartmouth-Hitchcock Medical Center

This research involved extensive video observation of pediatric procedural sedation in the hospital setting. The study sought to shift how medical practitioners viewed the concepts of safety and efficacy to all aspects of the sociotechnical system that impacts outcome. Specifically, this research aimed to characterize performance in a state-feedback control model that would allow critical factors affecting control to be identified and then utilized for system redesign.

The results of this research have led to a shift in our understanding regarding the undertreatment of pain and anxiety. Undertreatment errors should be viewed as a safety failure and are related to control failures in managing overdose events. Practitioners with unreliable systems for managing overdose states in patients routinely tolerate underdose states to create a margin of safety. These data fostered subsequent research focused on rescue systems and distributed teams. The initial study funded by NPSF was pivotal in allowing our research team to secure funding from the National Institute of Child Health and Human Development to use simulation to identify latent conditions preventing optimal rescue and control of rare but potentially lethal overdose events.

Ultimately, this project impacted the provision of sedation to pediatric patients at our hospital, resulting in improved safety and reliability for children who require painful and/or stressful procedures. We have implemented a sedation program that has now been in place for over eight years that was designed to optimize control.

“My greatest joy is to see the direct results of this research. We have now provided state-of-the-art sedation analgesia care to over 16,000 children at our hospital!”  — Dr. George Blike

Serious Medication Errors: Evaluation of Prevention Strategies in Pediatrics

Donald Goldmann, MD, and Rainu Kaushal, MD, MPH
Children’s Hospital

Medication errors are common in pediatric inpatients but few data are available regarding the efficacy of strategies to reduce errors in this setting. To measure the effects of implementing unit-based clinical pharmacists on rates of serious medication errors in three pediatric inpatient units (intensive care, general medical and general surgical) compared with three control units, we undertook a pre- and post-intervention comparison of all pediatric inpatients hospitalized in three intervention units over a 6-month period in addition to post-intervention comparisons with three control units. Data were prospectively collected five days per week by trained nurses who reviewed medication order sheets, medication administration records and charts in addition to obtaining voluntary and solicited reports from staff. Serious medication errors were defined as those errors which either caused patient harm or had the potential to cause harm and were not intercepted. The unit-based pharmacist endeavored to participate in physician rounds and was available for the remainder of the workday in the intensive care unit and for morning hours in the other two units.

The pre-intervention serious medication error rate per 1,000 patient days was 29 for the medical intensive care unit, 8 for the general medical unit, and 7 for the general surgical unit. Following the implementation of unit-based clinical pharmacists, the serious medication error rate dropped approximately five-fold in the intensive care unit (p 0.002). This post-intervention medical intensive care unit rate was also five-fold lower than the rate in the control unit during the same time period (p 0.0002). Part-time unit-based clinical pharmacists were not associated with a change in the rate in the general medical or surgical units.

A full-time unit-based clinical pharmacist decreased the serious medication error rate by almost five-fold in a pediatric intensive care unit. Clinical pharmacists may be as effective as computerized physician order entry and other forms of information technology in decreasing serious medication errors.
Improving Patient Safety in Cardiac Surgery via Prospective Use of the Cumulative Sum (CUSUM) Failure Method

Richard J. Novick, MD
London Health Sciences Center, Ontario, Canada

James S. Todd Memorial Award

Using a statistical methodology known as CUSUM, this two-year study analyzed the learning curves of new surgical consultants and surgeons engaged in minimally invasive cardiac surgery. The investigators anticipated that the CUSUM method would enable prospective analysis of the learning curves of new surgical consultants and of surgeons engaging in innovative, minimally invasive procedures. The goal of this study was to incorporate the CUSUM technique into standard methods of surgical audit to improve patient safety and outcomes after cardiac surgery.

The results of this study illustrate that prospective use of the CUSUM method can alert surgeons to suboptimal results and the need for prompt remedial action in advance of standard comparative analyses.

In a highly innovative field such as cardiac surgery where techniques are changing weekly, an “online” sequential probability assessment of patient outcomes is obligatory. The researchers have already noted significant interest in CUSUM analysis among the cardiac surgical community in North America and Europe and believe that it will have a significant impact on future outcome assessment in cardiac surgery.

Error Detection and Recovery: Fixation vs. Adaptability

William R. Torbert, PhD, and Jenny Rudolph, PhD
Boston College

Fixation error is the process of clinging to a single presumed diagnosis despite mounting cues that one is on the wrong track. This study sought to understand and reduce fixation error by anesthesiology residents during simulated acute medical crises.

Based on this study’s findings, it appears that fixated clinicians weigh the social and/or logistical costs of seeking help more heavily than its benefits. In their actions, fixated clinicians subvert self-correction by using weak diagnostic tests, by overusing assertion and advocacy, and by underusing inquiry or assumption testing.

This study highlights the fact that failures to handle crises effectively are related not to weaknesses in technical knowledge but rather to limits in reflection and communication.

1998–1999

Theory and Methods for Minimizing Drug Name Confusion Errors

Bruce L. Lambert, PhD
University of Illinois at Chicago College of Pharmacy

We conducted a study of the effect of similarity and prescribing frequency on pharmacists’ and consumers’ visual perception of drug names. We found that accuracy in visual perception of drug names was strongly influenced by both prescribing frequency and spelling similarity. The most commonly prescribed drugs were perceived much more accurately than the least commonly prescribed drugs. Also, we found that drug names with many similar “neighbors” were perceived less accurately than names with few neighbors. Findings were published in Social Science & Medicine in 2003. The study provided further validation for our computerized measures of similarity and further bolstered our claim that objective measures of similarity should be used as part of FDA’s pre-approval screening process for new drug names. In December 2003, the FDA announced that they would begin using a computer system that incorporated the measures we had validated in our NPSF-funded study. In an indirect way, our NPSF project led to changes in the way drug names are screened and approved in the United States. Health Canada has announced that they will be following FDA’s example, and they plan to adopt computerized name screening as part of their screening process as well.

In 2003, an offshoot of the NPSF work was funded by a four-year grant from the Agency for Healthcare Research and Quality. The results were published in Social Science & Medicine in 2010. We conducted auditory perception experiments to assess the impact of similarity, familiarity, background noise and other factors on clinicians’ and laypersons’ ability to identify spoken drug names. Accuracy increased significantly as the signal-to-noise (S/N) ratio increased, as subjective familiarity with the name increased and as the national prescribing frequency of the name increased. For clinicians only, similarity to other drug names reduced identification accuracy, especially when the neighboring names were frequently prescribed. When one name was substituted for another, the substituted name was almost always more frequently prescribed. We concluded that objectively measurable properties of drug names could be
used to predict confusability. The magnitude of the noise and familiarity effects suggested that they may be important targets for intervention.

"Receiving a grant from the NPSF was a watershed event in my career. This award provided national recognition for my work on drug name confusion, and it played a significant role in my eventual promotion. In that sense the award had a very significant positive effect on my professional life. More importantly, the award encouraged me to deepen my commitment to patient safety as the main focus of my research."

— Dr. Bruce Lambert

Looking for Trouble in All the Right Places: Electronic Decision Support for Error Reduction in a Large HMO

Gabriel J. Escobar, MD
Kaiser Permanente and Cornell University

The original hypothesis of this study was that it is possible to use commonly available hospital information systems to identify situations that have a high probability of being associated with human error. The objectives were to develop and validate a set of computer algorithms that would detect specific patterns of clinical, laboratory, and/or administrative data associated with extremely high-risk events in obstetrics.

The investigators have found that electronic scanning techniques can be highly effective in detecting high-risk events in perinatal care. The results have also confirmed that these techniques are superior to existing methods (e.g., voluntary incident reporting) used by hospital quality assurance departments.

Quantitative Measurement of the Progression of Clinical Expertise

Matthew B. Weinger, MD
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James S. Todd Memorial Award

This project measured the acquisition of clinical expertise throughout anesthesia residency training and compared resident performance with that of more expert anesthesia providers. The original hypothesis was that clinical expertise could be described by specific behavioral and cognitive processes. The original aims of the project were: 1) Examine the progression of residents’ technical skills over the course of anesthesia residency by measuring actual clinical performance; 2) Examine how cognitive models of a complex clinical decision evolve throughout residency training; and 3) Define the critical differences in technical and cognitive performance among anesthesia residents, CRNA, and Board-Certified anesthesiologists.

During the original project period, we collected task, workload, and vigilance data from hundreds of anesthesia cases performed by clinicians having a range of experience and training. The results suggest that, in similar cases, the residents’ task patterns, workload, and vigilance changes over the course of their training. Experienced clinicians are better able to allocate their cognitive, perceptual, and manual resources with changing clinical demands. We also examined how brand new anesthesia residents are taught patient care in the first weeks of training. The training of novices initially focuses on manual tasks with later addition of cognitive tasks. The workload of early trainees is very high and their capability to assimilate new data/tasks may be limited.

The NPSF funding allowed us to successfully undertake several related studies. Because our initial work suggested that task analysis could be an important way to assess what clinicians do during actual patient care (as well as during simulated care), we conducted a study to evaluate the intra- and inter-rater reliability of this technique. We also specifically examined the nature of intravenous drug preparation and administration tasks in cardiac and non-cardiac general anesthesics. During the case-specific data collection funded by the NPSF, we began to develop and refine our conceptual model and methods to capture “non-routine events” (or NRE). NRE are any events identified by clinicians or observers that represent deviations from optimal care for that specific patient in that specific clinical situation.

In conclusion, NPSF funding had a real impact on my career, that of my junior colleagues, and we believe on patient safety research more generally through the development of more rigorous methods of measuring care processes and their effects on safety. In addition to the results cited above, the early support of NPSF, and of the Anesthesia Patient Safety Foundation (APSF), fostered my team’s formative research agenda around the time of the release of the Institute of Medicine’s To Err Is Human. Since then, we have actively participated in more than a dozen federally funded patient safety projects amounting to nearly $7 million in direct costs, from the Agency for Healthcare Research and Quality (AHRQ), Veterans Administration Health Services Research and Development (HSR&D), National Library of Medicine, National Heart Lung and Blood Institute, and the United States Food and Drug Administration (FDA). My team has used these techniques to conduct high-quality research on various relevant patient safety topics (e.g., the effects of workload, fatigue, and distractions, as well as event capture) that has been published in a wide range of journals. We have also extended NPSF-funded research in anesthesiology to other disciplines (e.g., intensive care and operating room nursing, surgeons, inpatient medicine and pediatrics, ambulatory medicine, and even some initial work directly with patients). We have developed collaborations across the United States and our tools are also being used or emulated by investigators nationally and in other countries.

As of 2012, Dr. Weinger is at Vanderbilt University.
**Auditory Warning Signals in Critical Care Settings**

Yan Xiao, PhD, Jacob Seagull, PhD, and Colin Mackenzie, MD

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Alarms are critical defenses against preventable harms to patients, and alarms are ubiquitous because of ease in attaching them to almost any device. Yet instead of being a mechanism safeguarding the patient, alarms often increase workload, make communications difficult, and produce a hostile work environment. Care providers do not always respond to alarms. Why?

A multi-disciplinary team studied auditory alarms using methodologies of cognitive engineering to understand interactions with auditory alarms. Eye-tracking devices were used to understand both auditory and visual sources of information during critical care. Clinicians were found to ignore alarms and concentrate directly on the patient when they were overloaded. Patient monitors are scattered around the patient, making it difficult to gather visual information, yet auditory alarms provide little useful information. Interviews were used to understand reasons why alarms were ignored. Alarms were reported as compensatory solutions to poorly designed floor layouts, and physicians frequently overused monitored beds even for relatively healthy patients. These factors increased the occurrences of false alarms. This project demonstrated the value of cognitive engineering methods in understanding challenges to patient safety.

The NPSF funding provided the vital focus and visibility on patient safety in a number of human factors research activities by the project team. Subsequent to the NPSF project, the project team received major funding support from federal and non-federal sources on key aspects of patient safety. Some of the techniques developed during the NPSF project were instrumental. The funding further propelled the career pathways of the project team along improving patient safety. Currently Yan Xiao is developing implementation strategies within a large, integrated health care delivery organization after a successful career in academic research. Jacob Seagull is innovating patient safety education in a medical school.
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* Subsequent to receiving their awards, these individuals were invited to serve on the Committee

About NPSF

The National Patient Safety Foundation (NPSF) has been pursuing one mission since its founding in 1997 – to improve the safety of care provided to patients. As a central voice for patient safety, NPSF is committed to a collaborative multi-stakeholder approach in all that it does. NPSF is an independent, not-for-profit 501(c)(3) organization. To learn more about the work of the National Patient Safety Foundation visit: www.npsf.org.