

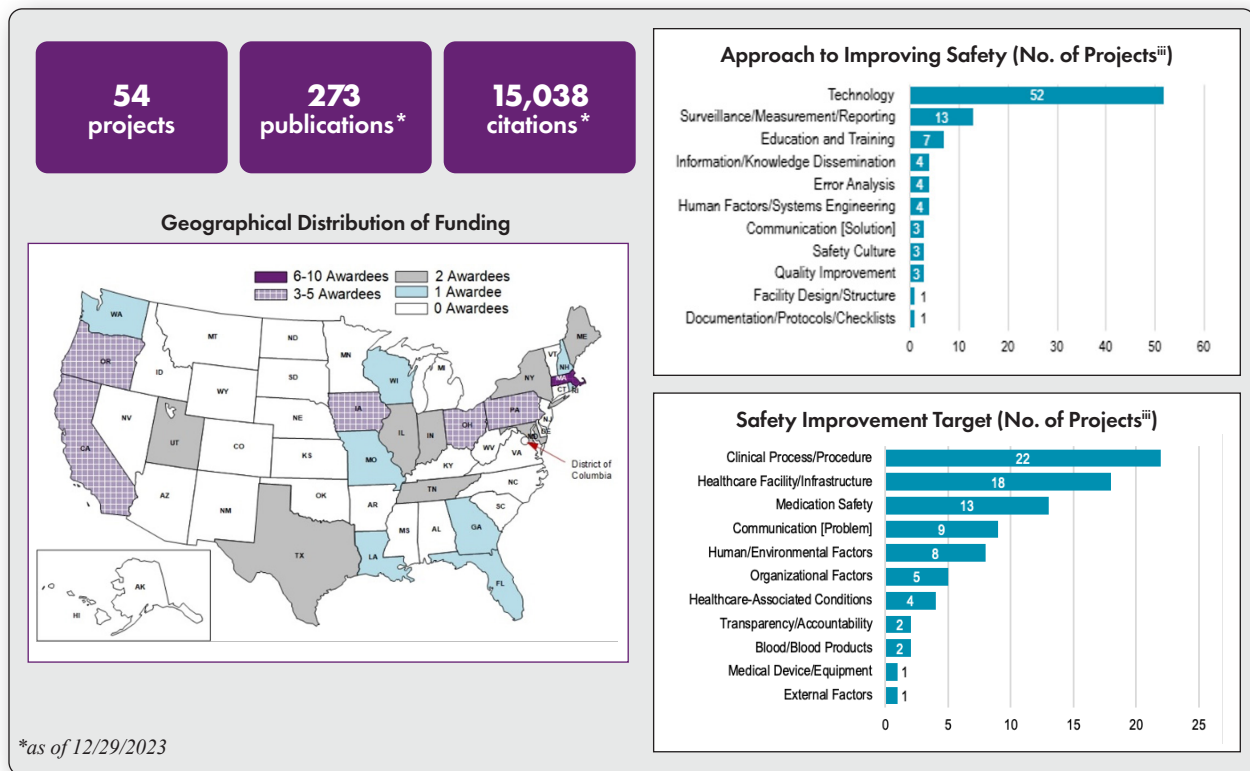
AHRQ-Funded Patient Safety Project Highlights

Improving Healthcare Safety by Enhancing Health Information Technology and Health Information Exchange

Overview

Research has shown that health information technology (HIT)ⁱ and health information exchange (HIE)ⁱⁱ make it possible for healthcare providers to safely and securely access and share information about a patient's health, such as patient history, vital signs, diagnoses, medications, and disease progression. Since 2000, AHRQ has supported 54 patient safety projects related to HIT and HIE. This publication summarizes AHRQ's investments in this promising pathway toward better care, including examples of project findings and products, collective outputs, and impacts of this work. Details about each AHRQ-supported project are available in the [Appendix](#).

Scope of AHRQ Investments



ⁱ Health information technology encompasses a wide range of technologies that use hardware, software, and/or infrastructure to manage health information (e.g., clinical, administrative, financial).

ⁱⁱ Health information exchange requires interoperability of systems and devices and allows healthcare providers (e.g., doctors, nurses, pharmacists) and patients to access and share patient medical information electronically.

ⁱⁱⁱ The total number of projects is greater than 54 as some projects used more than one approach to improving safety.



These projects produced at least 273 publications, which have been cited more than 15,038 times in other articles. The largest number of patient safety-related HIT and HIE projects (n=8) was awarded to institutions in Massachusetts.

Nearly all of the 54 projects (52, 96%) used technological approaches to improve patient safety. The most frequent safety targets were clinical process/procedure (n=22, 41%) and healthcare facility/infrastructure (n=18, 33%).

Examples of Project Findings

This collection of work includes patient safety projects using HIT and HIE to improve the safety, quality, timeliness, and cost of patient care. These research projects have demonstrated the value of HIT and HIE and have improved patient safety by generating new knowledge; developing, implementing, and evaluating tools, guidance, conceptual frameworks, and other interventions; and disseminating research findings.

Examples of these projects and summaries of their findings are provided below and are organized by research themes identified in this collection of work. The examples with asterisks (*) were funded in collaboration with the AHRQ Division of Digital Healthcare Research (DDHR) (formerly Division of Health IT).

Improving Medication Safety

AHRQ funded several projects focused on the use of technology to improve medication safety in a variety of healthcare settings.

- A [pharmacy barcode system](#)* for medications at Brigham and Women's Hospital resulted in fewer adverse drug events from dispensing errors and an annual savings of \$2.23 million.
- A [single electronic medication list](#) was developed by integrating data from three sources and resulted in a substantial increase in the number of accurate medication lists and patient adherence at participating clinics.
- One project, the [Geriatric Risk Assessment Med Guide](#) (GRAM™), evaluated the effectiveness of a clinical software program in long-term care pharmacies. Researchers found a reduction in potential delirium onset, overall hospitalization, and mortality of newly admitted nursing home residents.
- Another project demonstrated the effectiveness of a [computerized pharmacy alert system](#) and collaboration between healthcare professionals in decreasing potentially inappropriate medication dispensing.

Reducing Patient Harm and Identification Errors

AHRQ also funded projects that applied various technologies to improve patient safety by reducing harm and identification errors among patients.

- An AHRQ Patient Safety Learning Lab^{iv} (PSLL) developed an [electronic Fall TIPS Tool](#) to help patients, families, and professional care teams reliably identify, assess, and reduce patient safety threats in real time.
- A [computerized, bar-code-based tracking system for blood transfusions](#) was used to prevent patient identification errors and reduced voluntary incident reports.
- One project tested and implemented a [biometric patient identification and treatment verification system](#) using fingerprints to reduce the possibility of patient misidentification and did not identify any false positives.
- Another project advanced patient safety research by using a [large electronic health record \(EHR\) repository and an advanced medical language processing system](#) to automate and improve medical event detection.

^{iv} PSLLs take a systems engineering approach to allow researchers and healthcare practitioners to evaluate clinical processes and enhance work and information flow to improve patient safety. More [information about PSLLs](#) is on AHRQ's website.

Promoting Clinical Quality Improvement

Several AHRQ-funded projects aimed to help providers improve the quality of their clinical care by developing HIT cooperatives, using data registries, and assessing or applying health information tools and systems.

- The value of a [computerized clinic order entry tool](#)* was measured to promote the appropriate use of antimicrobial medications and resulted in more efficient clinical processes for prescribing medications.
- A longitudinal survey found that clinicians were increasingly in agreement that an [ambulatory computerized physician order entry system integrated with a clinical decision support system](#) in an outpatient EHR improved care quality, test result followup, and clinician communication.
- One project used a centralized EHR registry, the [Pediatric Emergency Care Applied Research Network Registry](#)*, to derive provider benchmarks for clinical quality improvement and comparative effectiveness research in pediatric emergency medicine care.
- One project developed a [rural HIT cooperative](#)* in Washington State, including a website of resources for hospital staff that resulted in significantly improved quality measures pertaining to acute myocardial infarction and community-acquired pneumonia.

Impacts

AHRQ-funded patient safety research in HIT and HIE has aimed to demonstrate the value of HIT and HIE and helped transform the healthcare sector by increasing efficiencies, decreasing expenditures, and increasing quality. The 54 projects in this collection of work have achieved their aims with varied outcomes but have collectively produced:

- An enhanced knowledge base (e.g., publications) about the planning, implementation, use, and sustainability of HIT and HIE solutions across various healthcare settings.
- Guidance, frameworks, tools, and other interventions (e.g., barcode medication administration technology, computerized physician order entry systems, pharmacy alert systems, and patient portals) to increase patient safety.
- Shared resources (e.g., websites, web-based platforms) to connect healthcare professionals across regions and provide real-time quality feedback

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

- Promote the adoption of HIT and HIE across the country (e.g., in rural and urban areas).
- Demonstrate how HIT and HIE can be used to improve reporting, conduct data analysis, and help providers learn from errors.
- Reduce patient harms and errors within hospital settings (e.g., falls, adverse drug interactions, patient misidentification).
- Improve health outcomes by providing quality data to providers and integrating order entry tools with existing clinical decision-making systems.
- Influence and impact the field of HIT and HIE research for a variety of interested parties (e.g., patients, patient safety researchers, policymakers, healthcare providers, and public health practitioners).

To learn more about each project included in the synthesis, refer to the [Appendix](#) that follows.

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Appendix

Health Information Technology and Health Information Exchange Project Summary

This appendix briefly describes AHRQ-funded patient safety-related HIT and HIE projects. Projects are organized first by state, then by original date of funding. The 19 grants with asterisks (*) after their grant numbers were funded in collaboration with the AHRQ Division of Digital Healthcare Research (DDHR) (formerly Division of Health IT), which has been funding a larger body of HIT work since 2004. In addition, the projects listed below are linked to the [NIH RePORTER](#), an electronic tool that allows users to search a repository of federally funded research projects and access publications resulting from such funding.

Principal Investigator Organization City, State	Project Number [Type] Project Title Project Period Total Investment	Purpose, Key Findings/Impact, and Number of Publications
CALIFORNIA		
Teryl Nuckols University of California, Los Angeles Los Angeles, California	K08 HS17954 [Grant] The Value of Hospital-Related Patient-Safety Interventions to Key Stakeholders 2009-2013 \$553,269	Purpose: To inform policymakers and others so they can prioritize quality and safety interventions, understand how to align economic incentives with implementation, and anticipate the consequences of policy decisions on quality, safety, and costs. Key Findings/Impact: Investigators created a probability model to evaluate the cost utility of implementing computerized provider order entry (CPOE) vs. paper ordering in four size categories of hypothetical U.S. acute care hospitals. The researchers found CPOE to be a better method than paper ordering, with anticipated savings of \$133 billion and 201,000 quality-adjusted life years between 2009 and 2013. Investigators concluded that results for hospitals will vary but, overall, CPOE with clinical decision support could result in substantial long-term savings. Investigators also previously reported the results of a systematic review and meta-analysis, indicating that implementing CPOE in hospital-related settings is associated with a greater than 50 percent decline in preventable adverse drug events (pADEs). Compared with paper order entry, CPOE was associated with half as many pADEs and medication errors. The investigator went on to obtain three grants (two from AHRQ) to continue research on the effect of quality of care and costs, using the Quality-Cost Framework developed under this grant. Publications (Products): 11
Tina Hernandez-Boussard Stanford University Stanford, California	R01 HS24096 [Grant] Improving Quality of Postoperative Pain Care Through Innovative Use of Electronic Health Records 2015-2020 \$250,000	Purpose: To measure quality of various care processes for postoperative pain, assess proposed evidence-based interventions from randomized controlled trials, lay the groundwork for systematic pain-related research using electronic medical records, and produce population-based evidence for a nationally endorsed postoperative pain management quality metric. Key Findings/Impact: The investigators developed a framework to use real-world data to assess pain management and prescription prescribing patterns. This framework allows them to generate evidence quickly and accurately on pain management practices and associated patient outcomes for clinical assertions. Publications: 21
Kevin Moore University of California, San Diego San Diego, California	R01 HS25440 [Grant] Distributed Knowledge-Based Platform for Radiotherapy Plan Quality Control 2018-2023 \$1,506,200	Purpose: To build ORBITeR (On-line Real-time Benchmarking Informatics Technology for Radiotherapy), a freely available, online knowledge-based quality control system for radiotherapy plans. The system would be on a web-based platform compliant with the Health Insurance Portability and Accountability Act and designed to give clinicians real-time feedback on radiotherapy plan quality. Key Findings/Impact: This project ran through March 31, 2024, and a final report is not available yet. However, the project team has published 15 articles on knowledge-based prediction models and tools for radiotherapy plans, automated knowledge-based planning across multiple disease sites, automated treatment planning, and automatic transit image acquisition for treatment error detection. Publications: 15

Principal Investigator Organization City, State	Project Number [Type] Project Title Project Period Total Investment	Purpose, Key Findings/Impact, and Number of Publications
Katherine Steffen Stanford University Stanford, California	R18 HS29298 [Grant] Transfusion Recommendations Implemented in the PICU (TRIP) 2023-2026 \$397,998	Purpose: To examine use of targeted efforts to improve implementation of pediatric transfusion guidelines and inform a future study that evaluates the impact of restrictive transfusion practices and implementation of the transfusion guidelines. The goal is to reduce unnecessary transfusions and improve patient outcomes in critically ill children. Key Findings/Impact: This project is ongoing until April 30, 2026, and no final report or publications are available yet. Publications: 0
COLORADO		
David Magid Kaiser Foundation Research Institute Aurora, Colorado	UC1 HS14249 [Grant] Improving Drug Safety: Linking Lab and Pharmacy Data 2003-2007 \$930,777 Final Report	Purpose: To refine and implement a pharmacy alert system that uses linked data from the Pharmacy Information System and the Laboratory Information System to identify and warn pharmacists of possible errors. Key Findings/Impact: Investigators sought to reduce medication errors for three high-risk groups: patients with chronic kidney disease, people taking high-risk drugs, and older patients. All three projects resulted in a measurable decrease in medication errors and these improvements were statistically significant at the p<0.05 level. Investigators noted the project on older patients demonstrated the effectiveness of a computerized tool plus collaboration between healthcare professionals in decreasing potentially inappropriate medication dispensing. They found that coupling data available from information systems with the knowledge and skills of physicians and pharmacists can improve prescribing safety among patients aged 65 and over. The study also was the first randomized study testing an intervention to decrease potentially inappropriate medication prescribing in older patients in which the intervention occurs at the point of medication dispensing. The results show a process that was effective at decreasing the percentage of older patients receiving these medications. This process included linking patient age and drug prescribing information to identify potentially inappropriate prescribing among patients aged 65 and over, providing that information to pharmacists, and then having pharmacists and physicians discuss safer medication alternatives. Publications: 7
Jerry Shenep St. Jude Children's Research Hospital Denver, Colorado	UC1 HS14295 [Grant] Risk Analysis of Pediatric Chemotherapy Processes 2003-2005 \$200,000 Final Report	Purpose: To evaluate the risks associated with each step of a complex chemotherapy process for possible failure points before and after using a commercially available integrated CPOE system at a leading children's cancer center. Key Findings/Impact: Investigators found that the chemotherapy ordering process already had multiple layers designed with patient safety in mind. Examples include multiple redundant checks for protocol compliance, dosage recalculation by nurses and pharmacists, transcription into a pharmacy computer system, and administration documentation on standardized forms. The facility fully implemented the CPOE system by 2010, including for chemotherapy orders, and a list of recommendations for the successful and safe implementation of CPOE for chemotherapy was developed. Extensive use of electronic order sets, formal process redesign and system analysis, careful and strategic use of clinical decision support, and a phased implementation approach were essential for safe implementation of CPOE for chemotherapy at St. Jude's. Collaboration and feedback with software providers were essential to achieve a safe and usable CPOE system for chemotherapy. Publications: 2

Principal Investigator Organization City, State	Project Number [Type] Project Title Project Period Total Investment	Purpose, Key Findings/Impact, and Number of Publications
FLORIDA		
Robert Wears University of Florida Gainesville, Florida	R18 HS17902 [Grant] Reducing Risks by Engineering Resilience Into Health Information for Emergency Departments 2008-2012 \$878,888	<p>Purpose: To develop guidance for care delivery organizations for safely and resiliently operating and maintaining their safety-critical HIT systems.</p> <p>Key Findings/Impact: Investigators reviewed and summarized data from 45 documents (e.g., general standards documents, U.S. government civilian guidance or standards documents, military standards, and scientific books or papers relevant to safety-critical computing) into 7 modules (IT safety management systems, risk assessment, change management, anomaly response, usability issues, legal and contracting issues, and adequacy of feedback).</p> <p>The consensus of both IT and management personnel was favorable in terms of usefulness and usability, but they expressed considerable concern that their organizations would not be willing to commit the time and effort needed to fully implement these procedures. These results suggest that care delivery organizations need assistance in attending to the deeper safety issue raised by HIT, perhaps even a need for either some sort of regulatory floor (beyond the Health Insurance Portability and Accountability Act), or at least a much broader awareness of the risks of current HIT.</p> <p>Publications: 9</p>
GEORGIA		
Swaminathan Kandaswamy Emory University Atlanta, Georgia	R03 HS2941Z [Grant] Human Factors and Implementation Evaluation of Pediatric AI Sepsis Model in the Pediatric Emergency Department 2023-2025 \$51,729	<p>Purpose: To measure implementation outcomes and establish the feasibility of measuring the mechanism of impact via human performance aspects such as trust, situational awareness, and workload.</p> <p>Key Findings/Impact: This project is ongoing until July 31, 2025, and no final report or publications are available yet.</p> <p>Publications: 0</p>
ILLINOIS		
Richard Koss Joint Commission Oakbrook Terrace, Illinois	R01 HS15164* [Grant] Toward an Optimal Patient Safety Information System 2004-2008 \$1,344,668 Final Report	<p>More information about this project, which was funded in collaboration with the AHRQ DDHR, is available at https://digital.ahrq.gov/ahrq-funded-projects/toward-optimal-patient-safety-information-system.</p> <p>Publications: 1</p>

Principal Investigator Organization City, State	Project Number [Type] Project Title Project Period Total Investment	Purpose, Key Findings/Impact, and Number of Publications
Mary Madison American Health Information Management Association Chicago, Illinois	R13 HS18117 [Grant] Setting a Quality Improvement Research Agenda To Leverage HIT/HIM in Rural America 2009-2010 \$48,035	<p>Purpose: To convene rural healthcare experts, providers, public health practitioners, patients, and other national and local health industry stakeholders for a summit titled "Setting a Quality Improvement Research Agenda To Leverage HIT/Health Information Management (HIM) in Rural America: A National Stakeholder Summit" on April 22 and 23, 2010, in Alexandria, Virginia.</p> <p>Key Findings/Impact: Three priorities emerged:</p> <ol style="list-style-type: none"> 1. Adoption and Use: Integrate HIM, HIT, and telehealth into quality improvement systems to enhance access and optimize healthcare in rural settings. 2. Underserved Populations: Use HIM, HIT, and telehealth to reduce disparities in healthcare treatment and outcomes, especially in rural low-income and underserved populations. 3. Economic Value: Use HIM, HIT, and telehealth to enhance clinical performance and thereby support the economic viability of rural healthcare. <p>Investigators noted the research agenda was ambitious, requiring public-private partnerships to implement, and recommended five steps for implementation. Rural providers' low uptake of HIM, HIT, and telehealth suggests the need to develop effective research-informed strategies for supporting deployment in rural settings.</p> <p>Publications: 0</p>
INDIANA		
J. Overhage Indiana University - Purdue University, Indianapolis (IUPUI) Indianapolis, Indiana	U18 HS11889 [Grant] Improved Patient Safety With Information Technology 2001-2005 \$1,518,420	<p>Purpose: To identify "indicators" of errors in ambulatory patient care in 18 practices that are part of a practice-based research network (ResNet).</p> <p>Key Findings/Impact: Investigators implemented two randomized trials, conducted a survey study, published an article (editorial comment) in JAMIA, successfully negotiated multiple organizational changes to IUMG-PC to decrease errors, and greatly expanded access to pharmacy data within the practices. Overall, they obtained preliminary evidence that organizational changes and academic detailing significantly decreased errors in these practices but continued to analyze results.</p> <p>Publications: 1</p>
Shaun Grannis Indiana University - Purdue University, Indianapolis (IUPUI) Indianapolis, Indiana	R01 HS18553 [Grant] Advancing Patient Identity Management in the Context of Real-World Health Information Exchanges 2009-2013 \$1,302,399	<p>Purpose: To (1) evaluate patient matching processes in an operational HIE; (2) apply novel modifications to existing matching algorithms; and (3) assess the value of matching across clinical sources both within and outside the HIE.</p> <p>Key Findings/Impact: The investigators reported a lack of data on best practices for patient matching approaches in learning healthcare systems that rely on electronic data; however, the investigators believe their work using probabilistic record linkage is accurate and can be feasibly applied to a variety of datasets ranging from clinical to population based. They demonstrated that matching methods can be applied to a variety of data, although barriers to optimal matching remain.</p> <p>Patient identification and record linkage is a key component of the emerging learning healthcare systems that leverage large quantities of integrated electronic data. The findings contribute to the body of record linkage knowledge and provide approaches to optimize record linkage outcomes.</p> <p>Publications: 4</p>
IOWA		
Toni Ebeling Hancock County Health Services Britt, Iowa	P20 HS15396* [Grant] EMR Planning To Improve North Iowa Health Care 2004-2005 \$199,976	<p>More information about this project, which was funded in collaboration with the AHRQ DDHR, is available at https://digital.ahrq.gov/ahrq-funded-projects/emr-planning-improve-north-iowa-health-care.</p> <p>Publications: 0</p>

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Loreen Herwaldt University of Iowa Iowa City, Iowa	UC1 HS14312 [Grant] Blood Product Transfusions and Safe Practices Implementation 2003-2005 \$2,289,505 Final Report	<p>Purpose: To use wireless mobile devices, barcode technology, and a new online data-capture-response tool to prevent patient identification errors that occur in the blood transfusion process. Specific points in which errors occur are when healthcare workers collect blood samples for type and cross-match, the blood bank evaluates blood samples, the blood bank dispenses blood products, and staff members administer blood products.</p> <p>Key Findings/Impact: Staff readily accepted a computerized barcode-based tracking system for blood transfusions. The system identified many more errors than the previous manual process, thereby improving patient safety. It reduced the number of monthly voluntary incident reports and reduced the blood sample rejection rate and delays in transfusions.</p> <p>Mis-scans and skipped steps were the most common errors in the first 10 months after implementation. In addition, it was estimated that mistransfusions could occur about once every 100 months on average with the new system. Researchers noted that implementing the transfusion system positioned the institution to implement similar technology for managing medication administration. They also believe their experiences and outcomes could help other healthcare institutions with their patient safety initiatives.</p> <p>Publications: 1</p>
Amany Farag University of Iowa Iowa City, Iowa	R18 HS29292 [Grant] Assuring Medication Safety in K-12 Schools: Implementing and Evaluating the Electronic School Medication Administration Record (E-SMAR) System 2023-2026 \$330,229	<p>Purpose: To reduce medication errors at schools by implementing and evaluating the usability and effectiveness of the Electronic School Medication Administration Record (eSMAR), a computer-based system.</p> <p>Key Findings/Impact: This project is ongoing until March 31, 2026, and no final report or publications are available yet.</p> <p>Publications: 0</p>
LOUISIANA		
T.B. Ferguson Louisiana State University, Health Sciences Center, New Orleans New Orleans, Louisiana	P20 HS15305* [Grant] Cardiovascular Care Disparities: Safety-Net HIT Strategy 2004-2005 \$194,499	<p>More information about this project, which was funded in collaboration with the AHRQ DDHR, is available at https://digital.ahrq.gov/ahrq-funded-projects/cardiovascular-care-disparities-safety-net-hit-strategy.</p> <p>Publications: 0</p>
Candice Ferguson Woman's Hospital Baton Rouge, Louisiana	P20 HS15435* [Grant] Distance Management of High-Risk Obstetrical Patients 2004-2006 \$187,624	<p>More information about this project, which was funded in collaboration with the AHRQ DDHR, is available at https://digital.ahrq.gov/ahrq-funded-projects/distance-management-high-risk-obstetrical-patients.</p> <p>Publications: 0</p>

Principal Investigator Organization City, State	Project Number [Type] Project Title Project Period Total Investment	Purpose, Key Findings/Impact, and Number of Publications
MAINE		
John Branscombe Aroostook Medical Center Presque Isle, Maine	P20 HS14949* [Grant] The Chronic Care Technology Planning Project 2004-2005 \$200,000	More information about this project, which was funded in collaboration with the AHRQ DDHR, is available at https://digital.ahrq.gov/ahrq-funded-projects/chronic-care-technology-planning-project . Publications: 0
Maureen Buckley Northeast Health Foundation Maine	P20 HS15170* [Grant] Midcoast Maine Patient Safety With IT Integration 2004-2005 \$200,000	More information about this project, which was funded in collaboration with the AHRQ DDHR, is available at https://digital.ahrq.gov/ahrq-funded-projects/midcoast-maine-patient-safety-it-integration . Publications: 0
MARYLAND		
Scott Levin Johns Hopkins University Baltimore, Maryland	R18 HS26640 [Grant] Connected Emergency Care (CEC) Patient Safety Learning Lab 2018-2022 \$2,435,858	Purpose: To reduce health and financial harms caused by suboptimal diagnosis, treatment, and disposition decisions using advanced data science methods and EHR-integrated clinical decision support. Key Findings/Impact: This project ran until December 31, 2023, and a final report is not available yet. However, as a result of this work, 14 publications have been produced on artificial intelligence-based clinical decision support for COVID-19, the association of targeted rapid testing for SARS-CoV-2 in emergency departments with large reductions in uninfected patient exposure time, SARS-CoV-2 positivity rates for Latino people in the Baltimore–Washington, DC, region, and open science in emergency medicine research. Publications: 14
Sadaf Kazi MedStar Health Research Institute Hyattsville, Maryland	R18 HS29291 [Grant] A Systems Engineering Approach To Optimize Pediatric Medication Safety 2023-2026 \$500,000	Purpose: To improve pediatric medication safety in the electronic health record (EHR) through optimization, deployment, and testing of an assessment tool designed to identify pediatric weight-based dosing errors. Key Findings/Impact: This project is ongoing until March 31, 2026, and no final report or publications are available yet. Publications: 0

Principal Investigator Organization City, State	Project Number [Type] Project Title Project Period Total Investment	Purpose, Key Findings/Impact, and Number of Publications
MASSACHUSETTS		
David Bates Brigham and Women's Hospital Boston, Massachusetts	P30 HS23535 [Grant] Making Acute Care More Patient-Centered 2014-2019 \$3,911,228	<p>Purpose: To develop tools to engage patients, families, and professional care team members in reliable identification, assessment, and reduction of patient safety threats in real time before they manifest in actual harm. To provide information, strategies, and tools for using HIT to facilitate patient activation in eliminating harm in hospital settings.</p> <p>Key Findings/Impact: Investigators found that implementing the Fall TIPS toolkit reduced patient fall rates. To improve this toolkit, they integrated the ABCs of harm into both the electronic and print versions, because patients are more likely to believe they need a fall prevention plan and then follow that plan if they know their risks of harm for falling. In addition, pilot testing of the MySafeCare dashboard to assess stakeholder engagement, increase awareness and use of the reporting dashboard, and assess willingness to engage with the reporting dashboard, revealed three main themes:</p> <ol style="list-style-type: none"> 1. Terminology to match hospitalized patient and family health literacy and shared understanding 2. Simplified intuitive workflow for patients and families who may experience barriers to navigating apps while in the hospital setting 3. User interface design for mobile devices <p>The Patient Safety Learning Lab intervention was implemented on 12 inpatient units during the 18-month study period, potentially affecting 12,628 patient admissions.</p> <p>Publications: 17</p>
Tejal Gandhi Brigham and Women's Hospital Boston, Massachusetts	R01 HS14053* [Grant] Using Barcode Technology To Improve Medication Safety 2003-2006 \$1,341,802 Final Report	<p>Purpose: To measure the impact of a new barcode/eMAR (electronic medication administration record) system on various kinds of medication errors.</p> <p>Key Findings/Impact: The financial investment for implementing a hospital-based pharmacy barcode system for medications yielded positive returns financially and in terms of mitigating errors. The project addressed key issues in a large academic setting, Brigham and Women's Hospital, leading to increased safety with dispensing medications. The primary benefit was a decrease in adverse drug events from dispensing errors, projected to be 517 events per year, resulting in an annual savings of \$2.23 million.</p> <p>Investigators also found that 25 percent of nurse time is spent on medication administration and another 25 percent on communication. A nursing satisfaction survey showed meaningful and statistically significant improved satisfaction scores after implementing the barcode technology. Investigators of this project concluded that barcode/eMAR technology shows great promise combined with a CPOE system with enhanced decision support capabilities. Such features would provide clinicians with direct access to important drug information, hospital policies concerning medication administration, and pertinent clinical results.</p> <p>Publications: 9</p>

Principal Investigator Organization City, State	Project Number [Type] Project Title Project Period Total Investment	Purpose, Key Findings/Impact, and Number of Publications
<p>Tejal Gandhi Brigham and Women's Hospital Boston, Massachusetts</p>	<p>R01 HS15226 [Grant] Improving Safety and Quality With Outpatient Order Entry 2004-2008 \$1,499,401 Final Report</p>	<p>Purpose: To evaluate the use of Partners Healthcare's ambulatory computerized physician order entry (ACPOE) system that is tightly integrated with an advanced clinical decision support system in the outpatient EHR, known as the longitudinal medical record (LMR).</p> <p>Key Findings/Impact: After implementation, the average adjusted overall time spent per scheduled patient increased, but the increase was not statistically significant. The average adjusted "face-to-face" time spent per patient decreased slightly, but the decrease (0.41 minutes) did not reach statistical significance. Surveys revealed that while many physicians agreed ACPOE improves the quality of patient care, a significant percentage also found the system difficult to use and a hindrance to their personal efficiency.</p> <p>Despite the drawbacks, most physicians recognized the system's potentially positive impact on financial outcomes. A longitudinal survey found an increase in the percentage of clinicians agreeing that the EHR improved quality of care, reduced medication-related errors, improved test result followup, and improved communication among clinicians. Over time, a decreasing percentage agreed that the EHR reduced the quality of patient interactions, resulted in longer patient visits, and increased time spent on medical documentation.</p> <p>Publications: 2</p>
<p>Li Zhou Brigham and Women's Hospital Boston, Massachusetts</p>	<p>R01 HS22728* [Grant] Encoding and Processing Patient Allergy Information in EHRs 2013-2018 \$1,959,741</p>	<p>More information about this project, which was funded in collaboration with the AHRQ DDHR, is available at https://digital.ahrq.gov/ahrq-funded-projects/encoding-and-processing-patient-allergy-information-ehrs.</p> <p>Publications: 27</p>
<p>Yuri Quintana (formerly Charles Safran) Beth Israel Deaconess Medical Center Boston, Massachusetts</p>	<p>R18 HS24869 [Grant] Leveraging a Social Network of Elders and Families To Improve Medication Safety at Transitions of Care 2016-2020 \$1,482,263 Final Report</p>	<p>Purpose: To expand the functionality of the InfoSAGE platform by including a mobile-first/point-of-care medication manager that helps older people and their families keep an accurate medication list, coordinate the list with prescribing clinicians, track the impact of medications on symptoms, view medication precautions and drug-drug interactions, and become more engaged as partners in their care.</p> <p>Key Findings/Impact: Investigators studied 587 users of the InfoSAGE platform (366 older users and 221 other users) and found that modern design may be more suited to experienced or habitual app users and is more prone to confusion in aging populations. Hesitation and frustration issues steadily declined in progression as scenarios were completed but remained the most frequently observed event in each scenario, suggesting the user interface needs further improvement.</p> <p>Investigators recommended that app developers for mixed populations of ages, especially those with an emphasis on older adults (65+), use prominent navigation elements, such as shadows and raised buttons or linear navigation. Consistency in navigation elements such as buttons for submission and going back reduces errors due to misclicks. Buttons should also be apparent, using drop shadows or conspicuous shapes and placement. Clickable text should stand out, using underlining, color change, or larger font. Linear navigation, which avoids scrolling, simplifies routes through the app.</p> <p>The investigators assessed the usability and e-health literacy needs for platform adoption and usage, and their research has shown that it is possible to recruit adults over 75 and their families to use online and mobile technologies for information sharing and care coordination.</p> <p>Publications: 6</p>

Principal Investigator Organization City, State	Project Number [Type] Project Title Project Period Total Investment	Purpose, Key Findings/Impact, and Number of Publications
David Bates Brigham and Women's Hospital Boston, Massachusetts	U18 HS11046 [Grant] Improving Quality With Outpatient Decision Support 2000-2003 \$1,614,021	Purpose: To (1) improve understanding of the gaps between evidence and practice; and (2) overcome system barriers (e.g., inadequate resources and physician misunderstandings or noncompliance) using computer-based decision support. Key Findings/Impact: Paper-based reminders for health maintenance, disease-specific therapies, cost-effective substitutions, and diabetes management significantly helped improve compliance, particularly for diabetes and health maintenance. Investigators also developed and implemented the LMR Results Manager application in eight primary care clinics, and a randomized controlled trial of its impact was underway at the time of their report. Baseline data, however, showed that 59 percent of physicians expressed dissatisfaction with the way they managed test results, and 83 percent of physicians reported at least one delayed result review in a 2-month period. Physicians who reported fewer delays in result reviews were more likely to be satisfied, as were those who tracked test orders to completion. Publications: 14
Ramin Khorasani, Ronilda Lacson Brigham and Women's Hospital Boston, Massachusetts	R18 HS29348* [Grant] DECODE: Diagnostic Excellence Center on Diagnostic Error 2022-2026 \$992,942	Purpose: To establish a diagnostic center of excellence that will focus on reducing diagnostic errors related to diagnostic imaging in two ways. Key Findings/Impact: This project is ongoing until September 29, 2026, and a final report is not available yet. Publications: 2
MISSOURI		
Gregory Alexander University of Missouri, Columbia Columbia, Missouri	R01 HS22497 [Grant] A National Report of Nursing Home Quality Measures and Information Technology 2017-2022 \$2,744,284	Purpose: To develop, validate, and pilot an expert consensus-based nursing home IT maturity survey. Key Findings/Impact: This grant ended recently, so a final report is not yet available. This grant has resulted in 18 publications to date, primarily focused on information technology and quality measures used in nursing home or long-term care settings (e.g., trends, sophistication, national reports, data sharing, use). This grant is therefore significant because national assessments of nursing home IT maturity and maturity stages have not been measured previously or linked with national nursing home quality measures. Publications: 23
NEW HAMPSHIRE		
Deane Morrison Concord Hospital Concord, New Hampshire	P20 HS15414* [Grant] Electronic Communications Across Provider Settings 2004-2005 \$197,649	More information about this project, which was funded in collaboration with the AHRQ DDHR, is available at https://digital.ahrq.gov/ahrq-funded-projects/electronic-communications-across-provider-settings . Publications: 0

Principal Investigator Organization City, State	Project Number [Type] Project Title Project Period Total Investment	Purpose, Key Findings/Impact, and Number of Publications
NEW YORK		
Rita Kukafka Columbia University, School of Health Sciences New York, New York	R03 HS16333 [Grant] Communicating Probabilities Through Interactive Computer Graphics 2006-2009 \$100,000	<p>Purpose: To develop novel interactive computer graphics to communicate risks and assess their impact on decision making and risk perception.</p> <p>Key Findings/Impact:</p> <ol style="list-style-type: none"> 1. It is possible and potentially beneficial to tailor graphics for people with different levels of expertise or skills. The interactive search graphics developed in this grant sharply reduced the differences in interpretation and decisions between readers with high and low levels of numeracy. These or other types of graphics could be used to compensate for low numeracy, thus helping people perform at a higher level. 2. It is important to design graphics to support specific goals (e.g., information, education, persuasion, decisions). Design decisions can have unintended consequences on these goals. Sometimes, the goal is to persuade people to avoid hazards and adopt healthy lifestyles. In other cases, such as recruiting participants for medical research, persuasion is unacceptable. <p>Publications: 5</p>
George Hripcsak Columbia University School of Health Sciences New York, New York	R18 HS11806 [Grant] Mining Complex Clinical Data for Patient Safety Research 2001-2004 \$1,085,608	<p>Purpose: To use an EHR and natural language processing (NLP) to automate and improve medical event detection, providing a unique opportunity to apply the most advanced medical language processing system to a large comprehensive clinical repository that can advance patient safety research.</p> <p>Key Findings/Impact: Investigators reported results regarding explicit voluntary error reporting in the medical record, conflicts in the record, specific event detection, case-based reasoning on an errors database, cognitive studies, and error terminology. They also published the results of an assessment that used discharge summaries to determine how effectively NLP detects adverse events defined in the New York Patient Occurrence Reporting and Tracking System.</p> <p>The investigators concluded that NLP is an effective technique for detecting a broad range of adverse events in text documents and outperformed traditional and previous automated adverse event detection methods.</p> <p>Publications: 15</p>
OHIO		
Randall Cebul Case Western Reserve University Cleveland, Ohio	R01 HS15123* [Grant] Trial of Decision Support To Improve Diabetes Outcomes 2004-2008 \$1,495,569	<p>More information about this project, which was funded in collaboration with the AHRQ DDHR, is available at https://digital.ahrq.gov/ahrq-funded-projects/trial-decision-support-improve-diabetes-outcomes.</p> <p>Publications: 2</p>

Principal Investigator Organization City, State	Project Number [Type] Project Title Project Period Total Investment	Purpose, Key Findings/Impact, and Number of Publications
<p>Jason Sohn Case Western Reserve University Cleveland, Ohio</p>	<p>R18 HS17424 [Grant] Developing a Medical Biometric Identification System With a Secure Database Network 2010-2014 \$1,127,223</p>	<p>Purpose: To develop a patient identification and treatment procedure verification system, using fingerprints, that calls up existing hospital applications such as treatment record and verification (R&V) systems or picture archiving and communication systems following correct patient identification. Since the system does not rely on human interactions, it lowers the possibility of medical errors.</p> <p>Key Findings/Impact: Investigators successfully developed and were testing a fingerprint identification database that could be integrated with hospital applications. The system accepts a fingerprint, identifies the patient, verifies with a second fingerprint, and opens the correct patient record in the R&V database. The system was implemented in Radiation Oncology and Surgery, but investigators could only recruit 73 of 600 patients.</p> <p>Investigators tested and recommended using a newer scanner that acquires both fingerprints and finger vein patterns for biometric matching data to reduce the database match failure rate. Patients over 75 years old tended to have poor quality fingerprints, accounting for most of the failed matches. An important safety feature of the system was that it did not identify any false positives.</p> <p>Publications: 5</p>
<p>Maya Dewan, Matthew Zackoff Cincinnati Children's Hospital Medical Center Cincinnati, Ohio</p>	<p>R18 HS29626 [Grant] Digital Innovation, Simulation, and Collaboration using Virtual Environment Realities (DISCOVER) for Pediatric Diagnostic 2023-2027 \$500,000</p>	<p>Purpose: To envision, develop, prototype, and test design-informed clinical decision support approaches to improving diagnosis in an existing highly immersive virtual clinical world.</p> <p>Key Findings/Impact: This project is ongoing until July 31, 2027, and no final report or publications are available yet.</p> <p>Publications: 0</p>
<p>Maya Dewan, Matthew Zackoff Cincinnati Children's Hospital Medical Center Cincinnati, Ohio</p>	<p>R18 HS29630 [Grant] SAMURAI PICU: Situation Awareness incorporating Multidisciplinary Teams Reduce Arrests In the Pediatric ICU 2023-2028 \$397,831</p>	<p>Purpose: To evaluate the use of the SAMURAI PICU (Situation Awareness incorporating MULTidisciplinary teams Reduce Arrests In the PICU) bundle to improve early identification of high-risk patients, increase shared situation awareness, and support risk mitigation plans and thereby reduce pediatric in-hospital cardiac arrest and improve patient safety.</p> <p>Key Findings/Impact: This project is ongoing until July 31, 2028, and no final report or publications are available yet.</p> <p>Publications: 0</p>

Principal Investigator Organization City, State	Project Number [Type] Project Title Project Period Total Investment	Purpose, Key Findings/Impact, and Number of Publications
Michael Rothberg Cleveland Clinic Foundation Cleveland, Ohio	R01 HS22883 [Grant] Patient-Centered Approach to Reducing Harm From VTE 2014-2019 \$993,115	<p>Purpose: To use data from many patients at the Cleveland Clinic to create tools that physicians can use to assess an individual patient's risk of both venous thromboembolism (VTE) and bleeding and to weigh those risks.</p> <p>Key Findings/Impact: Investigators indicated that they could create a risk prediction model for VTE in the hospital. The model had good discrimination and performed better than the Padua model in their validation set. Their decision analytic model identified a threshold for prophylaxis based on VTE risk. They also found that (1) the threshold was sensitive to patient age but they did not think it could be operationalized within the randomized trial, and (2) the decision to offer prophylaxis was relatively insensitive to bleeding risk.</p> <p>The investigators concluded that it is possible to predict VTE with data available in the EHR at admission. Patients with an overall risk of at least 0.8 percent should receive prophylaxis, although this threshold can be adjusted for age or life expectancy. A risk calculator using this information can be incorporated into an EHR. Their study assessing the impact on patient outcomes is ongoing.</p> <p>Publications: 1</p>
OREGON		
Jeffrey Gold Oregon Health and Science University Portland, Oregon	R01 HS25141 [Grant] Creation and Validation of a Training Toolkit To Ensure Safe and Proficient Use of EHR by Medical Scribes 2017-2022 \$1,974,404 Final Report	<p>Purpose: To fully assess the scope of scribe use with respect to the EHR and use this information in conjunction with national experts in EHR safety and medical documentation to establish a series of entrustable professional activities (i.e., key tasks that can readily be performed) for medical scribes.</p> <p>Key Findings/Impact: This grant ended recently, so a final report is not yet available. However, it has published research on a national survey of healthcare providers and findings indicate wide variability in their training and tremendous intrascribe variability in note creation and structure. The average scribe captured only 40 percent of the diagnoses or plans mentioned in a simulation, with less than 40 percent overlap in documentation between scribes. Further, every participating scribe documented several incorrect plan and diagnosis items.</p> <p>Publications: 11</p>
Ronald Stock PeaceHealth, Inc./ Sacred Heart Medical Center Springfield, Oregon	UC1 HS14315 [Grant] The PeaceHealth Community-wide Electronic Shared Medication List Study 2003-2006 \$990,053	<p>Purpose: To improve medication safety in the outpatient arena by using a communitywide electronic medication list and shared care plan.</p> <p>Key Findings/Impact: A key result of this project was the development and deployment of a single medication list that was created electronically by integrating data from the Primary Health Medical Group (PHMG) Shared Care Plan, a web-based personal health record, and clinic electronic medical records (EMRs) to create a single, web-based view.</p> <p>This medication reconciliation process resulted in a substantial increase in the number of accurate medication lists at its clinics, with fewer discrepancies between what the patient was actually taking and what was recorded in the EMR. PHMG created a medication reconciliation task force in their five regions to redesign clinical practice, incorporating the systemwide aims and agreed-on key process components for every ambulatory visit. The standardized processes can be replicated at other ambulatory clinics, even if electronic tools are not available.</p> <p>Another product of this project was the development and fielding of the PeaceHealth Ambulatory Medication Safety Culture Survey. Investigators created a 16-item survey to measure the degree to which a culture of medication safety existed within ambulatory clinics.</p> <p>The investigators concluded that the measure was psychometrically strong and capable of assisting in the improvement of medication management safety. The investigators noted that further development of the instrument was needed to better define survey subdimensions.</p> <p>Publications: 1</p>

Principal Investigator Organization City, State	Project Number [Type] Project Title Project Period Total Investment	Purpose, Key Findings/Impact, and Number of Publications
Jeffrey Gold Oregon Health & Science University Portland, Oregon	R18 HS27119 [Grant] A Turn-Key EHR Simulation Program To Reduce Diagnostic Error in Ambulatory Care 2019-2024 \$50,000	<p>Purpose: To create and validate a turn-key library of EHR-based simulations to improve diagnostic safety in ambulatory care that is both generalizable and scalable.</p> <p>Key Findings/Impact: This project is ongoing until August 31, 2024, and a final report is not available yet.</p> <p>Publications: 2</p>
Jeffrey Gold Oregon Health & Science University Portland, Oregon	R18 HS29345* [Grant] Diagnostic Accuracy Through Advancing EHR display, Education and Surveillance (DATA-EYES) 2022-2026 \$1,999,995	<p>Purpose: To better define the relationship between diagnostic error and EHR use through the analysis of medical malpractice cases and patient safety event report forms related to diagnostic error in ambulatory care.</p> <p>Key Findings/Impact: This project is ongoing until September 29, 2026, and no final report or publications are available yet.</p> <p>Publications: 0</p>
PENNSYLVANIA		
James Walker Weis Center for Research, Geisinger Clinic Danville, Pennsylvania	P20 HS15457* [Grant] Regional Approach for THQIT in Rural Settings - Planning (THQIT = Transforming Healthcare Quality through Information Technology) 2004-2005 \$200,000	<p>More information about this project, which was funded in collaboration with the AHRQ DDHR, is available at https://digital.ahrq.gov/ahrq-funded-projects/regional-approach-thqit-rural-settings.</p> <p>Publications: 0</p>
Elizabeth Alpern Children's Hospital of Philadelphia Philadelphia, Pennsylvania	R01 HS20270* [Grant] Improving the Quality of Pediatric Emergency Care Using an Electronic Medical Record 2011-2017 \$2,336,497	<p>More information about this project, which was funded in collaboration with the AHRQ DDHR, is available at https://digital.ahrq.gov/ahrq-funded-projects/improving-quality-pediatric-emergency-care-using-electronic-medical-record.</p> <p>Publications: 16</p>
Francis Richards Weis Center for Research, Geisinger Clinic Danville, Pennsylvania	UC1 HS16162* [Grant] Regional Approach for THQIT in Rural Settings—Implementation 2005-2009 \$1,499,999	<p>More information about this project, which was funded in collaboration with the AHRQ DDHR, is available at https://digital.ahrq.gov/ahrq-funded-projects/regional-approach-transforming-healthcare-quality-through-information.</p> <p>Publications: 0</p>

Principal Investigator Organization City, State	Project Number [Type] Project Title Project Period Total Investment	Purpose, Key Findings/Impact, and Number of Publications
Akira Nishisaki Children’s Hospital of Philadelphia Philadelphia, Pennsylvania	R01 HS29188 [Grant] Smart Checklist Implementation for Pediatric Tracheal Intubations in the ICU - Multicenter Study: SMART PICU 2023-2028 \$400,000	Purpose: To transform the safety of pediatric tracheal intubation at six pediatric ICUs by implementing a digitized Smart Checklist with three specific features: prompts based on patient characteristics, direct display of difficult airway status and airway information, and high-risk warning based on predictive analytics. Key Findings/Impact: This project is ongoing until June 20, 2028, and no final report or publications are available yet. Publications: 0
Kristin Rising Thomas Jefferson University Philadelphia, Pennsylvania	R18 HS29791 [Grant] Targeted EHR-based Communication of Diagnostic Uncertainty (TECU) in the ED: An Effectiveness Implementation Trial 2023-2027 \$499,999	Purpose: To leverage the EHR to implement a multifaceted strategy to facilitate higher quality discharge transitions for patients discharged from the ED with diagnostic uncertainty. Key Findings/Impact: This project is ongoing until July 31, 2027, and no final report or publications are available yet. Publications: 0
RHODE ISLAND		
Kate Lapane Brown University Providence, Rhode Island	R18 HS11835 [Grant] Pharmacist Technology for Nursing Home Resident Safety 2001-2005 \$1,049,840 Final Report	Purpose: To evaluate the effectiveness of the clinical software program Geriatric Risk Assessment Med Guide™ (GRAM™) in nursing facilities to improve medication safety. Key Findings/Impact: GRAM triggered monitoring plans for a number of residents among participating nursing homes. Newly admitted residents in the intervention homes experienced a lower rate of potential delirium onset, overall hospitalization, and mortality than those in usual care homes. In longer stay residents, the effects of the intervention were attenuated. The investigators concluded that using health information technology in long-term care pharmacies to identify residents who might benefit from prospective medication monitoring care plans when complex medication regimens carry risks for falls and delirium may reduce adverse effects associated with appropriate medication use. Publications: 3
TENNESSEE		
Kevin Johnson Vanderbilt University Nashville, Tennessee	R03 HS16261 [Grant] Show Your Work: Do Prescription Annotations Impact Near Miss Medication Errors? 2006-2007 \$100,000 Final Report	Purpose: To assess the impact of prescriptions incorporating patient medications, allergies, weights, dosing guidelines, and other prescribing-strategy data on near-miss medication errors. Key Findings/Impact: This study was the first of its kind to examine the incorporation of a prescription annotations tool in an e-prescribing system. Results suggest that a relatively low-cost, easy-to-implement intervention can affect the pharmacist’s perceived effectiveness and foster more effective partnering with prescribers. The investigators believe these findings support the continued use of this approach. Publications: 1

Principal Investigator Organization City, State	Project Number [Type] Project Title Project Period Total Investment	Purpose, Key Findings/Impact, and Number of Publications
TEXAS		
Eric Thomas University of Texas Health Science Center Houston, Texas	R13 HS13928 [Grant] Tools and Methods for Monitoring Patient Safety 2003 \$20,323	Purpose: To develop and implement a 1-day preconference workshop, "Tools and Methods for Monitoring Patient Safety: The Role of Medical Records Review," on March 1, 2003, prior to the AHRQ Patient Safety Initiative Second Annual Meeting, March 2-4, 2003, in Arlington, Virginia. Key Findings/Impact: A final report for and products of this grant were not available or could not be found. Publications: 0
Hardeep Singh Baylor College of Medicine Houston, Texas	R18 HS29347* [Grant] Diagnostic Safety Center for Advancing E-triggers and Rapid Feedback (DISCOVERI) 2022-2026 \$1,994,147	Purpose: To accelerate uptake of e-triggers for measurement of diagnostic safety across the United States in organizations that value Learning and Exploration of Diagnostic Excellence (LEDE organizations). Key Findings/Impact: This project is ongoing until September 29, 2026, and a final report is not available yet. Publications: 7
UTAH		
Matthew Samore University of Utah Salt Lake City, Utah	R01 HS15413* [Grant] Rural Trial of Clinic Order Entry With Decision Support 2004-2008 \$1,499,650	More information about this project, which was funded in collaboration with the AHRQ DDHR, is available at https://digital.ahrq.gov/ahrq-funded-projects/rural-trial-clinic-order-entry-decision-support . Publications: 0
Nathan Dean IHC Health Services, Inc. Salt Lake City, Utah	R18 HS26886 [Grant] Adaptation and Pilot Implementation of a Validated, Electronic Real Time Clinical Decision Support Tool for Care of Pneumonia Patients in 12 Utah Urgent Care Centers 2020-2023 \$1,331,667	Purpose: To adapt and evaluate an innovative, validated electronic clinical decision support tool based on consensus guidelines for pneumonia in urgent care centers. Key Findings/Impact: This project is ongoing until September 29, 2024, and a final report is not yet available. Publications: 2
WASHINGTON		
Jacqueline Huck Rural Healthcare Quality Network Seattle, Washington	R01 HS15188* [Grant] A Rural Health Information Technology Cooperative To Promote Clinical Improvement 2004-2008 \$1,498,916	More information about this project, which was funded in collaboration with the AHRQ DDHR, is available at https://digital.ahrq.gov/ahrq-funded-projects/rural-health-information-technology-cooperative-promote-clinical-improvement . Publications: 0

Principal Investigator Organization City, State	Project Number [Type] Project Title Project Period Total Investment	Purpose, Key Findings/Impact, and Number of Publications
WISCONSIN		
Pascale Carayon University of Wisconsin, Madison Madison, Wisconsin	UC1 HS14253 [Grant] Medication Error Reduction, Technologies, and Human Factors 2003-2006 \$725,514 Final Report	<p>Purpose: To examine the impact of the implementation of medication administration technology, namely Smart intravenous pumps and barcode medication administration technology, using human factors techniques.</p> <p>Key Findings/Impact: Prospective risk analysis and usability testing improved the implementation of the Smart IV pump technology. Perceptions related to pump functioning, interface, improved patient safety, and ease of use predicted pump acceptance. Medication administration errors decreased, and few pump-related errors were made.</p> <p>Investigators identified a number of clinicians' workarounds when using barcoded medication administration systems, identified the causes and possible consequences of each workaround, and developed a typology. Investigators also concluded that design of sociotechnical systems, in collaboration with both workers and customers, requires increasing attention to design and implementation, continuous adaptation, and improvement of systems in collaboration with customers.</p> <p>Publications: 16</p>

