



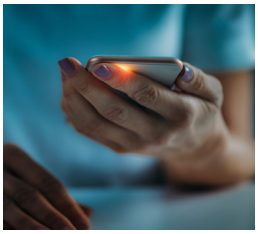



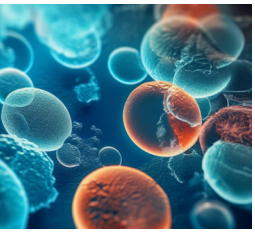

Improving Healthcare Through AHRQ's Digital Healthcare Research Program

2022 Year in Review

Agency for Healthcare Research and Quality

Improving Healthcare Through AHRQ's Digital Healthcare Research Program

2022 Year in Review

Prepared for:
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Executive Summary

A message from the Director of the Digital Healthcare Research Program

The digital healthcare landscape continues its dynamic shift, as new technologies and methods are emerging rapidly.

At AHRQ's Digital Healthcare Research (DHR) Program, we strive to inform digital healthcare evolution through rigorous research and evidence-based practice. Our portfolio focuses on three themes of vital importance to our program's strategy for putting technology to work in healthcare:

- Engaging and empowering patients
- Optimizing care delivery for clinicians
- Supporting health systems in advancing care delivery

Chris Dymek, Ed.D.
Director, AHRQ's Digital Healthcare Research Division

"At the Digital Healthcare Research Program, our work is driven by a vision in which every patient and care team has ready access to health data and knowledge at the point of care. Digital healthcare technologies hold the key to this vision, and research holds the key to ensuring that these technologies advance care quality, safety, and effectiveness."

In 2022, DHR managed a significant body of research across these themes:

115 grants and research contracts led by researchers at

69 institutions across

25 states and the District of Columbia

Our investment this year totaled

$29 million including:

- $14.3 million from the DHR appropriation
- $13 million from the Patient-Centered Outcomes Research Trust Fund
- $1.7 million from the General Health Services Research appropriation.

This 2022 annual report features 16 research stories—told in the Principal Investigators' own words—that capture the breadth and depth of our efforts to advance digital healthcare technologies to meet the evolving needs of patients, clinicians, and health systems. The report also demonstrates our commitment to advance knowledge and practice by disseminating findings and outcomes. This year, DHR-funded researchers engaged healthcare systems, providers, and implementers of healthcare technologies by sharing their findings at national conferences and webinars, and in more than 100 publications.

The research required to produce results that merit broad dissemination takes time and dedication. Our Research Spotlight this year underscores DHR's steady commitment to time-tested methods and high-quality studies. In a year in which ChatGPT dominated conversations, we see this steadiness as an asset. The Research Spotlight explores the potential of artificial intelligence (AI) in healthcare and how decades of research on health information technology can help guide the development and implementation of healthcare AI.

My colleagues and I are pleased and proud to share this report with the digital healthcare technology community and the many people who are working to improve healthcare for all Americans.

We welcome comments or questions about this report or our program at DigitalHealthcareResearch@ahrq.hhs.gov.

Research Spotlight

The Algorithm Is In: Is Adoption of Healthcare AI Outpacing Understanding?

Our Nation's strategy for better healthcare hinges on putting digital technologies to work.

Today's powerful tools make it easier to capture and share patient information, coordinate care, and streamline clinical workflows. However, these technologies also have created some unintended consequences. Health systems have massive data sets to manage, and providers face burdensome documentation requirements, voluminous charts to review, and overflowing inboxes.

As the healthcare industry looks for relief, artificial intelligence (AI) may offer solutions. AI-enabled systems can help humans perform key functions—diagnostics, decision support, administrative tasks—faster and, in some cases, with enhanced accuracy. At the same time, AI's risks warrant serious consideration.

As healthcare AI moves from promise to practice, we must mitigate its potential to exacerbate biases, privacy violations, access divides, and health inequities. We must also ensure that AI-enabled health technologies are safe for patients.

To steer the healthcare industry toward a safe, effective rollout of AI technologies, we need rigorous research and evaluation.

Interest, Adoption, and a Window for Gathering Evidence

Across the digital healthcare technology community, it's clear that AI has reached an inflection point. Scan a list of recent conferences, research journals, and trade publications, and you'll see a spiking interest in the promise and pitfalls.

For a variety of reasons, this interest has not yet translated into broad-based adoption. According to the Brookings Institute, healthcare lags far behind other industries in implementation of AI-enabled technologies. While some may be eager to accelerate the pace, this delay also presents a window of opportunity—one that DHR and AHRQ as a whole, as well as other agencies and

coalitions, can use to begin gathering evidence to help guard against AI's risks while maximizing benefits for providers and patients.

This is no small feat. The healthcare AI landscape is a blur of challenges: rapidly accelerating development, nascent but evolving policy guidance, the understandable clamor among providers for burden relief, and the numerous familiar hurdles associated with adopting new technology into clinical practice.

A Running Start on Healthcare AI Research

Already, DHR has studies underway that are exploring healthcare AI, amounting to 17% of our new grants funded since 2020 (AHRQ-Funded Projects).

We also have an immense body of research on digital healthcare technologies to help frame our thinking about AI.

For example, we can evaluate the lessons learned in the early years of health IT implementation, when adoption of electronic health records (EHRs) was lagging behind promises for improving care quality. We can also develop tools to assess patient safety outcomes associated with healthcare AI, as we did for computerized physician order entry systems. Similarly, we can apply the results of ongoing efforts to develop a framework and guide to counter persistent digital divides and healthcare inequities, which may be exacerbated by AI-enabled solutions.

These and other findings from decades of work to date can help guide the research needed to support implementation of healthcare AI.

The Need for Agile Research Mechanisms

Even as we seize the advantages of existing models and frameworks, an AI-enabled world demands an agile approach to research. While traditional grant mechanisms that fund 5-year studies are important, they will not produce the timely evidence we need to keep pace with the development of or the burgeoning need for healthcare AI. Rather, studies must take an iterative approach—learning and refining as they go—to produce actionable insights and recommendations before adoption outpaces understanding.

AHRQ is well positioned to play a role in applying current and emerging research methods to answer pressing questions about AI-enabled healthcare solutions.

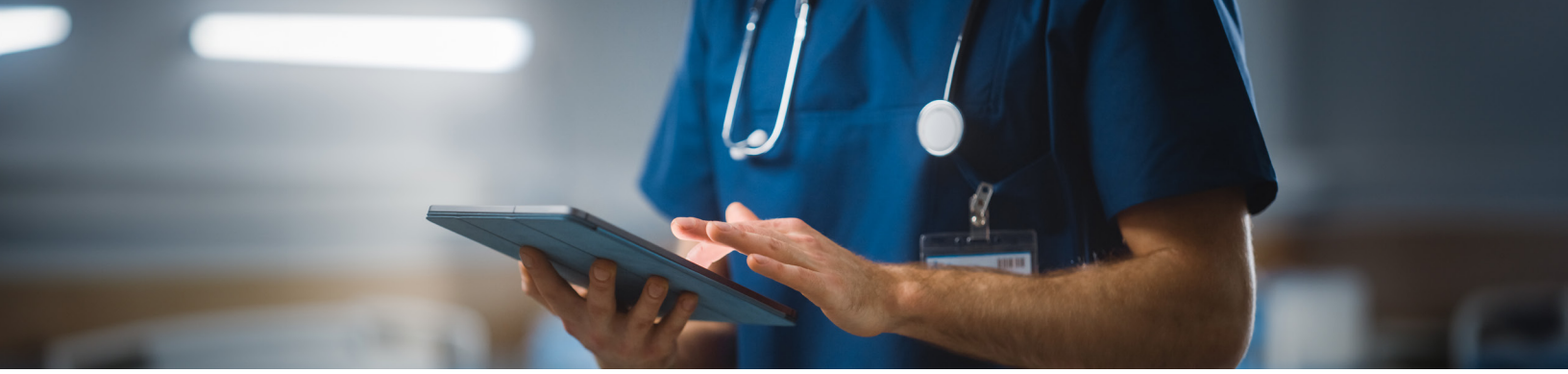
To make this happen, priorities may need to shift to fund more research that is conceptual or exploratory. Existing grant mechanisms such as R21 and R33 grants are ideal for pilot studies that can be scaled. However, given the blazing pace of enabling technologies like ChatGPT, even these mechanisms may be too slow, driving funders to consider yet more agile study approaches.

Balancing Research Priorities

Even as the excitement around AI dominates conversations, research priorities must strike a balance. Vital questions about EHRs, clinical decision support systems, and other foundational technologies remain—particularly their effects on health outcomes and health equity. These systems represent the backbone of America's healthcare transformation, and many of the insights gained from their continued study will be directly applicable to healthcare AI.

It's imperative that DHR receive adequate funding to conduct the rigorous research this field needs.

While the pace of healthcare AI may necessitate new and more nimble research methods, AHRQ's DHR program remains steadfast in its purpose and commitment. Across our endeavors, we will continue to work toward a digital health ecosystem that ensures patients and their families have access to safe, effective, equitable, and high-quality care.



Research Themes and Findings

The DHR program funds research that demonstrates how digital healthcare solutions can be designed and implemented to improve healthcare system performance and patient health outcomes. Our funded research focuses on advancing patient safety, care, and shared decision making without placing excessive burden on users, including patients, physicians, and other members of care teams.

In 2022, the DHR program managed 108 grants and seven research contracts across the three main themes:

- **Engaging and Empowering Patients**
- **Optimizing Care Delivery for Clinicians**
- **Supporting Health Systems in Advancing Care Delivery**

This report highlights research stories that showcase significant findings and impact under each theme. The research stories are identified as completed or emerging (newly funded) research.

- Completed research: 28 grants and 3 contracts recently ended.
- Emerging research: 23 grants recently awarded

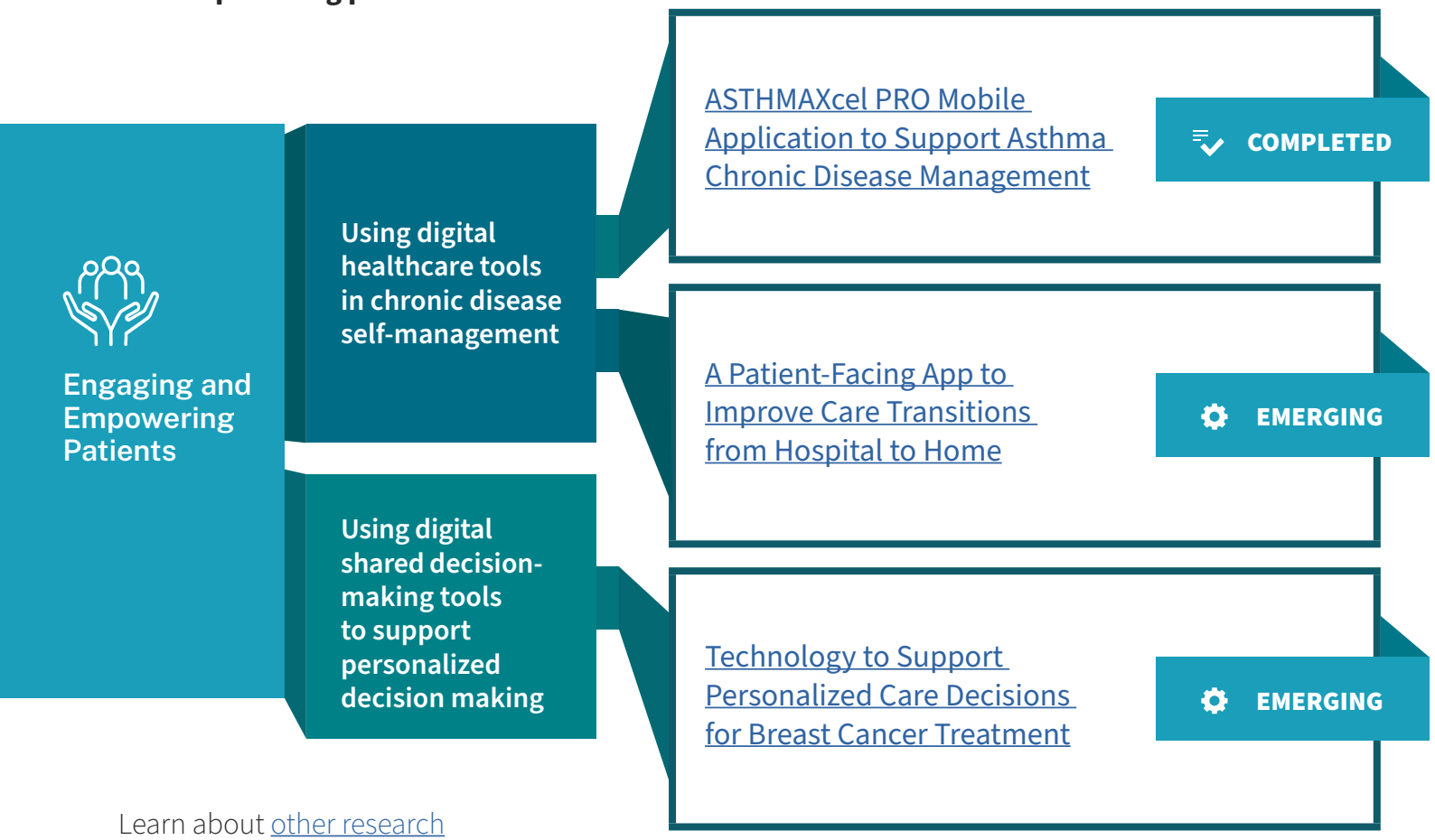
Engaging and Empowering Patients

Engaging and empowering patients in their own healthcare leads to improvements in safety, quality, and satisfaction of care. Use of digital healthcare tools, like patient portals, smartphones, or mobile apps, can facilitate patient engagement and empower patients and their caregivers to participate more actively in their own health self-management, chronic care management, and wellness at the many points of interaction with the healthcare system.

In 2022, DHR invested $72.3 million in grants and contracts across the lifetime of the projects to help patients, families, and health professionals work together as partners in promoting care improvements over the duration of the projects.

Below are research stories told in the investigator's own words that focus on engaging and empowering patients.

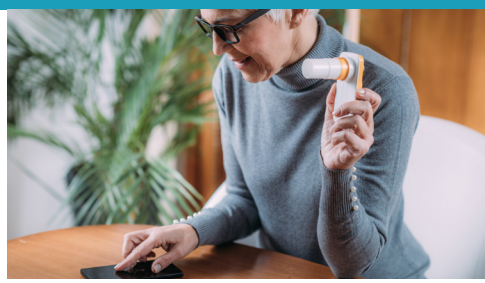
Below are research stories told in the investigator's own words that focus on **engaging and empowering patients**.



Learn about other research related to this theme.

ASTHMAXcel PRO Mobile Application to Support Asthma Chronic Disease Management

A mobile application designed to facilitate asthma self-management and shared decision making through patient-reported outcomes can improve care, asthma control, and knowledge, as well as decrease healthcare utilization.



PRINCIPAL INVESTIGATOR(S)

Sunit P. Jariwala, M.D.

ORGANIZATION
Albert Einstein College of Medicine

RESEARCH PROFILE
Adapting, Scaling, and Spreading an Algorithmic Asthma Mobile Intervention to Promote Patient-Reported Outcomes Within Primary Care Settings

FUNDED AMOUNT
$1,481,014

RESEARCH TYPE
Completed

Many factors contribute to poor health outcomes for people with asthma

Mortality rates related to asthma for Bronx residents are the highest in New York State, with Black and Hispanic people disproportionally affected. Many factors contribute to the high asthma burden in the Bronx, including poverty, environmental triggers, suboptimal access to healthcare, lack of patient knowledge regarding proper medication use, and difficulty adhering to medical regimens.

Primary care providers who use evidence-based asthma guidelines and provide asthma education to patients are critical to achieving asthma control. However, during time-constrained visits, providers often have limited time to discuss asthma symptoms or triggers and to provide asthma education.

Use of patient-reported outcomes will improve patient self-management and shared decision making between patients and providers

Dr. Sunit Jariwala, a practicing allergy immunology clinician and board certified clinical informaticist, together with a team of researchers from the Albert Einstein College of Medicine, set out to find a solution to better deliver evidence-based care and patient education to people with asthma, including providing guidance and support between clinic visits. The team developed the ASTHMAXcel PRO mobile application, which facilitates the collection and use of patient-reported outcomes (PROs), to improve self-management and shared decision making so that patients can achieve optimal asthma control. Collecting PRO measures is at the

core of ASTHMAXcel PRO and is crucial to the app's adaptive and personalized nature.

The research team involved patients, their families, and clinicians in the iterative development of the app, which is tailored to the needs of clinicians and patients and is optimized for use in primary care settings. To best facilitate the submission of PROs, the research team included specific platform features requested by patients. For example, the app has virtual coins, virtual trophies, and virtual leaderboards that patients suggested would incentivize them to use the app. The app, available on both iOS and Android, also includes nine chapters of guidelines-based asthma education. And to engage patients, the app offers push notifications for daily medication reminders, weekly messages of encouragement and behavioral support, and monthly check-ins on recent asthma-related hospital visits and steroid courses. This research shows the power of user-centered design: these features that the patients initially suggested were most indicative of their engagement once the app rolled out.

> "We saw the positive impact [of the tool] on asthma control and asthma quality of life, as well as trends of decreased Emergency Department (ED) visits, hospitalizations, and steroid courses for the patients."
>
> **Dr. Sunit P. Jariwala**

App improves patient care and has been successfully adapted for other conditions

Dr. Jariwala and team evaluated the ASTHMAXcel PRO mobile intervention in a randomized controlled trial and found that the use of the app significantly improved asthma quality of life, control, and knowledge, as well as decreased healthcare utilization. The app has since been extended to nine additional medical conditions, showing the value of mobile apps and participatory design for PROs collection and use to improve patient self-management and health outcomes. In addition, the team recently was awarded a followup grant from AHRQ to adapt the ASTHMAXcel platform to incorporate voice samples and social determinants of health data with the goal to favorably impact asthma control.

A Patient-Facing App to Improve Care Transitions from Hospital to Home

A patient-facing app simplifying the information patients and caregivers receive has the potential to better engage patients and families in their healthcare post-discharge and reduce adverse events.

PRINCIPAL INVESTIGATOR(S)

Lipika Samal, M.D.

Patricia Dykes, Ph.D., M.A., R.N.

ORGANIZATION
Brigham and Women's Hospital

RESEARCH PROFILE
Care Transitions App for Patients with Multiple Chronic Conditions

FUNDED AMOUNT
$2,000,000

RESEARCH TYPE
Emerging

Care transitions from hospital to home can be a vulnerable time for patients

For hospitalized patients, the transition from the hospital back to their home is a vulnerable time. Complications, such as falls or medication errors, could lead to readmissions. This is especially true for older adults with multiple chronic conditions. These complications are caused by a variety of factors, including poor communication among the inpatient care teams, primary care teams, and patients and their families; poor quality and timeliness of discharge information; and poor patient understanding of care plans.

An app will provide support before and after discharge

Traditionally, hospital patients are given their post-discharge care plan instructions, the opportunity to ask questions, and a followup appointment with their primary care team when they are being discharged from the hospital. But no such transitional support or instruction is offered during the hospitalization or after discharge and prior to the followup appointment. Drs. Lipika Samal and Patricia Dykes from Brigham and Women's Hospital wanted to know what would happen if patients and their families were provided more transition information during their hospitalization, as well as self-management reminders between discharge and their post-discharge followup appointment, and a summary of significant issues to share with their providers during the followup appointment.

To do this, the research team is developing a care transitions app for patients with multiple chronic diseases and their caregivers to better support the patient's transition from hospital to home to primary care followup, and to reduce adverse events in the first 30 days after discharge. The app will facilitate pre-discharge conversations with providers, provide personalized falls-reduction information (e.g.,

based on their current medications), offer a digital post-discharge transitional care plan, deliver medication reminders and education, and allow for patients to submit questions and recovery goals before their post-discharge clinic visit. It will also prompt patients to report symptoms so providers can monitor their progress and provide support as needed.

> "We want patients to use the app to start to have a conversation about discharge before it happens. If we wait until it's time to go, there's no time to do anything. And then once they get home, they'll get reminders for any medications that they're supposed to be taking. It also asks them to rate their symptoms, whether they're new or worse since their discharge. And then we tell them what to do if they have worsening symptoms."
>
> **Dr. Patricia Dykes**

A digital navigator will overcome the digital divide

One unique aspect of this intervention is that the team is introducing a digital navigator—a team member who will assess a patient's digital literacy and provide appropriate training. Drs. Samal and Dykes hope that having a digital navigator work directly with patients will overcome challenges and hesitancy to use the app.

Ultimately, the goal of the research is to reduce post-discharge complications for high-risk patients. The team will study the app's effectiveness, noting whether its use decreases falls, adverse medication events, and rehospitalizations, and whether it improves increased patient engagement and patient self-efficacy in managing their chronic diseases. If successful, the research team plans to share its knowledge and develop a toolkit to support widespread dissemination of the app.

Technology to Support Personalized Care Decisions for Breast Cancer Treatment

Enhancing personalized care decisions, using technology designed with human factors engineering approaches, can improve breast cancer care quality.

PRINCIPAL INVESTIGATOR(S)

Megan Elizabeth Salwei, Ph.D.

ORGANIZATION
Vanderbilt University Medical Center

RESEARCH PROFILE
Computerized Patient-centered Collaborative Technology (COMPACT) to Support Personalized Decision Making in Breast Cancer

FUNDED AMOUNT
$480,536

RESEARCH TYPE
Emerging

Patients face an array of breast cancer treatment options

Breast cancer is the second most common cancer in women, but treatment decisions can be complex. Each treatment option brings different benefits, risks (e.g., short- and long-term side effects), and implications (e.g., treatment duration) for the patient. Women need to be fully informed of all viable treatment options, and their treatment decisions should be based on their values, preferences, and goals.

It is challenging to successfully discuss all relevant factors in time-constrained clinical encounters, and patients may not divulge all personal issues and needs. For example, a mother with small children may have constraints given her family needs, while chemo-induced brain fog may significantly affect the working life of a teacher. These factors can have major impacts on the patient and their quality of life. How can we better support women in weighing the pros and cons of treatment options so that the path they select best aligns with their values, preferences, and goals?

> "One of the patient advisory members is a long-distance runner. She had breast cancer and had to have chemotherapy and got significant neuropathy in her feet and in her hands, which can be a common side effect of chemotherapy, and she's no longer able to run. Luckily, she's in remission, but running was a really big hobby of hers, a passion of hers. I am trying to think of things like that, that might become a part of the conversation when patients are diagnosed and choosing between different options."
>
> **Dr. Megan Salwei**

Technology will help support team decision making in breast cancer

To better support more comprehensive, personalized decision making when selecting breast cancer treatment options, Dr. Megan Salwei and a team from Vanderbilt University Medical Center are developing a tool called COMputerized PAtient-centered Collaborative Technology (COMPACT).

COMPACT will gather relevant information from patients on their preferences, goals, and questions ahead of a patient's visit via a patient portal. It will then integrate that information with evidence-based guidelines and medical data from the woman's electronic medical records, such as age, genetic testing results, and tumor type, to generate patient-optimized treatment options. The tool will present this information in a shared display to facilitate real-time conversations between clinicians, patients, and family caregivers as they make treatment decisions.

COMPACT will be unique compared to other decisions aids because it will support the entire decision-making process in a woman's breast cancer journey: before, during, and after initial treatment discussions. The technology will support patients throughout their cancer journey by monitoring treatment progress and supporting additional decision making when the care trajectory deviates from the desired path.

The system will be designed with users in mind

COMPACT will be developed using human factors engineering, which focuses on designing systems to support the strengths and constraints of the people within the system. This ensures the COMPACT technology will fit patients' and providers' needs in the environment that it will be used. As Dr. Salwei noted, "The human-centered design process ensures that whatever I develop is supporting the users, which would be patients as well as clinicians."

Once developed, the team will evaluate COMPACT in a simulated environment to understand how users interact with the technology, record how long it takes them to have conversations with the tool, and determine if it improves knowledge and confidence of decision making. Ultimately, Dr. Salwei hopes the results of this grant will inform a future randomized controlled trial of COMPACT to study its impact on patient care in a real-world setting.

Engaging and Empowering Patients: Other Research

The research stories highlighted in this report are only a subset of the work that AHRQ funds. The following table includes additional research related to Engaging and Empowering Patients that was either completed or newly awarded in 2022. To search the entire portfolio of research, please visit AHRQ Funded Projects.

Using digital healthcare tools in chronic disease self-management

Mobile health applications adapted with automated learning algorithms can target specific health conditions, such as improving the management of diabetes and depression while delivering adaptive messages based on patients' behaviors.	Access Dr. Aguilera's Project Profile
The use of a mobile health application can improve chronic disease self-management and medication adherence for people with HIV.	Access Dr. Schnall's Project Profile
Expansion of an evidence-based digital health intervention for attention deficit hyperactivity disorder in children that is focused on improving communication and care coordination across multiple points of care has the potential to improve outcomes for this group of individuals.	Access Dr. Lakes' Project Profile
While "cold" texting of patients to suggest screening for diabetes is feasible from a technological and governance perspective, more research is needed to inform how to better engage patients.	Access Dr. Wells' Project Profile

Using digital shared decision-making tools to support personalized decision making

The use of Support-Engage-Empower-Diabetes (SEE-Diabetes), a user-centered shared decision-making module, may improve self-care behaviors and outcomes for older adults with diabetes.	Access Dr. Kim's Project Profile
Use of a standards-based shareable, interoperable patient-facing clinical decision support tool for high blood pressure management has the potential to improve outcomes by empowering patients and providing them the tools to better engage in the self-management of their high blood pressure.	Access Drs. Dorr, and Koopman's Project Profile

Using patient-facing applications to empower patients in their care

Identifying and characterizing the factors differentiating patient portal users from nonusers within population subgroups can inform clear design guidelines to represent the diverse needs of patients to increase access and utilization of patient portals.	Access Dr. Ahmed's Project Profile
The use of an application employing Substitutable Medical Applications Reusable Technologies (SMART®) on Fast Healthcare Interoperability Resources (FHIR®) standards has the potential to improve guideline-directed medication therapy in those with heart failure, and if successful, the approach could reduce heart failure hospital admissions and be applied to other chronic conditions.	Access Dr. Dorsch's Project Profile
A multicomponent digital health solution has the potential to improve glycemic control and outcomes in Medicaid-enrolled pregnant individuals with type 2 diabetes.	Access Drs. Fareed, Joseph and Venkatesh's Project Profile
A family-centered multi-component digital tool with an innovative communication approach may reduce childhood obesity risk, as well as contribute to the limited evidence base of effective, culturally relevant mHealth tools for minority, at-risk populations.	Access Dr. Leung's Project Profile
Using CareHeroes, an application to support caregivers of those living with dementia, has the potential to support caregivers by making information on dementia readily available and creating the ability to track and share information about the impacted person between caregivers and providers.	Access Dr. Ruggiano's Project Profile

Using technology solutions to optimize pain management

Measuring patient-reported outcomes for pain management after certain dental procedures with a mHealth platform is feasible and improves patient-provider communication, patient-provider relationship, and the ability to manage pain medication prescribing.	Access Dr. White's Project Profile
The use of a virtual reality app has the potential to be a cost-effective way to alleviate pain, reduce the need for opioids, and improve outcomes for children needing at-home dressing changes for burn injuries.	Access Dr. Xiang's Project Profile

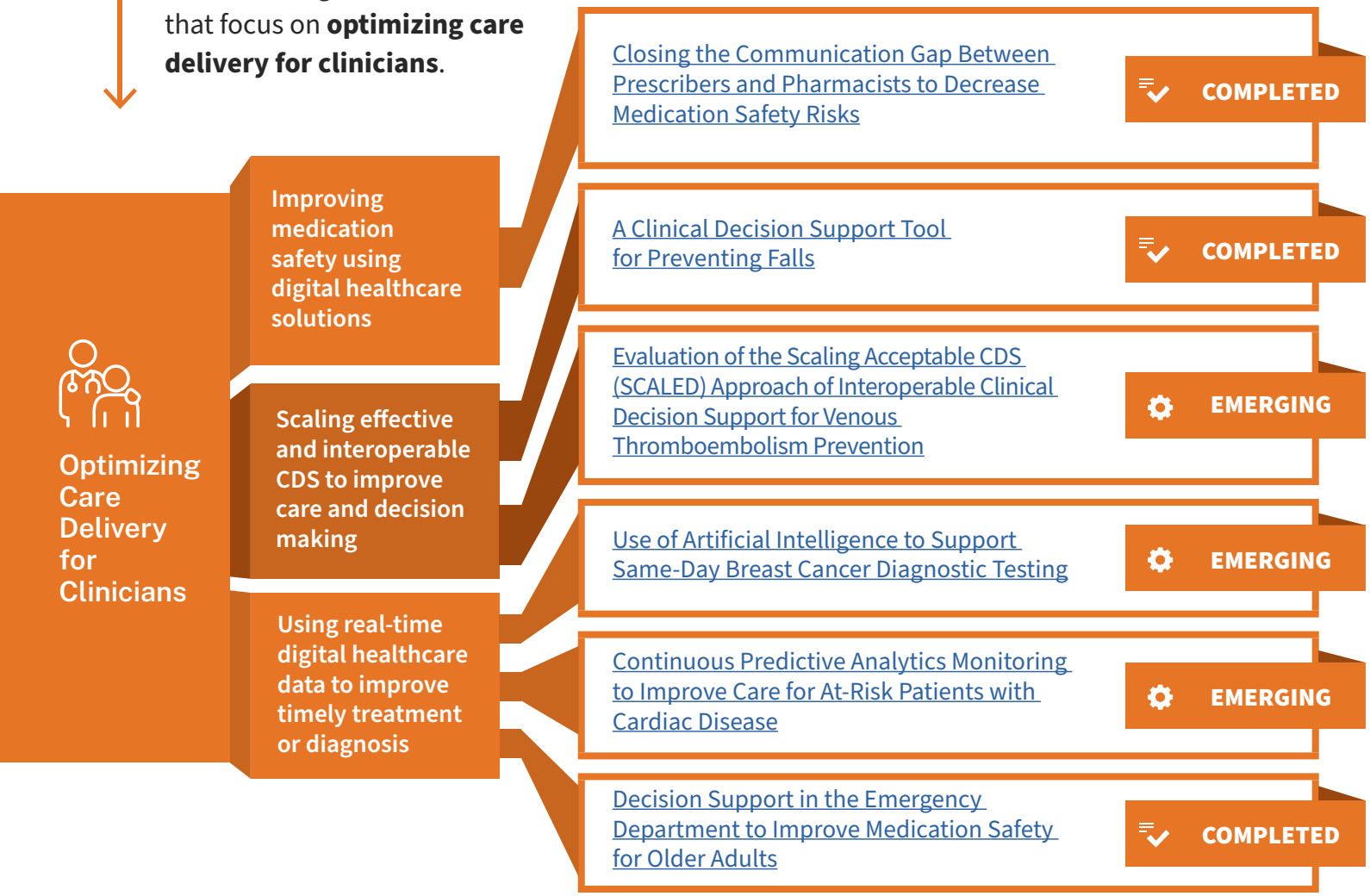
Optimizing Care Delivery for Clinicians

Supporting clinicians and other healthcare professionals by maximizing their ability to provide high-quality and safe healthcare to patients leads to improved health outcomes. For example, using digital health research to optimize clinical decision making by delivering the right information to the right people at the right times, allows clinicians to make the best treatment decisions, while also ensuring that technology is designed in a way that supports cognitive work and does not introduce or increase provider burden.

In 2022, the DHR program invested $55.2 million over the duration of research on projects that focused on optimizing care delivery for clinicians, including research on using effective clinical decision support (CDS) interventions to improve care, using real-time digital healthcare data to improve timely treatment or diagnosis, and technology solutions to improve medication safety.

Below are research stories told in the investigator's own words that focus on optimizing care delivery for clinicians.

Below are research stories told in the investigator's own words that focus on **optimizing care delivery for clinicians**.



Learn about other research related to this theme.

Closing the Communication Gap Between Prescribers and Pharmacists to Decrease Medication Safety Risks

Implementing CancelRx, an e-prescribing tool to electronically communicate medication discontinuation orders between electronic health records and pharmacies, showed an immediate and persistent reduction in prescriptions that were dispensed after discontinuation.

PRINCIPAL INVESTIGATOR(S)

Samantha Pitts, M.D., M.P.H.

ORGANIZATION
Johns Hopkins University

RESEARCH PROFILE
Understanding CancelRX: Impact on Clinical Workflows, Medication Safety Risks, and Patient Outcomes

FUNDED AMOUNT
$297,196

RESEARCH TYPE
Completed

A gap in relaying a prescription change can lead to an adverse drug event

When a medical provider discontinues a patient's medication, the prescription change is updated in the provider's electronic health record (EHR). However, this update is not always reflected in a pharmacy's medication list for the patient, which can lead to erroneously filling prescriptions that are no longer prescribed by their provider. Communication of medication discontinuation between prescribers and pharmacies is critical to medication management and preventing adverse drug events (ADEs). Dr. Samantha Pitts, faculty in General Medicine at Johns Hopkins, was driven by her experience as a prescribing provider and her recognition of the safety risk for patients and sought to explore how an existing tool—CancelRx—could be expanded to close the communication gap between providers and pharmacists.

Communication is key to ensuring medication safety

CancelRx is an e-prescribing tool that electronically communicates medication discontinuation updates in the provider's EHR to pharmacies. The tool allows pharmacists to have patients' current prescription information and notifies them when a provider discontinues a patient's prescription. Dr. Pitts sought to identify how this tool directly impacted dispensing after the discontinuation of medication, and to develop strategies to optimize implementation of CancelRx in the Johns Hopkins Health System. Through observation and key informant interviews, the research team worked to understand how staff were using the tool and where there might be information needs or gaps.

> "Realizing that there was a gap in communication between me—as a prescriber—and pharmacy staff was a motivating factor [to implement CancelRx] with the ultimate goals of improving communication and ensuring medication safety."
>
> **Dr. Samantha Pitts**

Implementing CancelRX led to immediate improvement and increased information exchange

The CancelRx implementation showed an immediate decrease in prescriptions that were dispensed after discontinuation in the EHR, from 8 percent to 1.4 percent. Dr. Pitts' team found that pharmacy staff sought additional information on the medication discontinuation, including clinical rationale for changes, and new medication guidance for patients. Dr. Pitts is encouraged that this tool has significant impact in reducing medication discrepancies and enhancing patient safety, and that CancelRX can potentially capture the needs of pharmacists and providers to ensure patient medication information is accurate. Adoption of CancelRx and expanding its functionality to include medications from outside the EHR could further reduce the risk of medication errors.

A Clinical Decision Support Tool for Preventing Falls

Tools like ASPIRE that integrate fall prevention clinical decision support and patient resources may better support patient self-care and adoption of evidence-based recommendations.

PRINCIPAL INVESTIGATOR(S)

Patricia Dykes, Ph.D., M.A., R.N.

ORGANIZATION
Brigham and Women's Hospital

RESEARCH PROFILE
Shareable, Interoperable Clinical Decision Support for Older Adults: Advancing Fall Assessment and Prevention Patient-Centered Outcomes Research Findings into Diverse Primary Care Practices (ASPIRE)

FUNDED AMOUNT
$993,595

RESEARCH TYPE
Completed

Falls can have devastating health consequences for older adults but are not often discussed in primary care

More than one in four older adults report falls each year, a common occurrence and the leading cause of fatal and nonfatal injuries in the United States. Fall prevention is possible, but older adults who are at the highest risk of falling need to receive appropriate interventions and referrals from their primary care providers (PCPs). Despite recognizing the need, PCPs do not routinely ask older patients about falls and associated risk factors. And research has shown that even when patients fall, they don't talk about it with their doctors, which only furthers the need to address fall prevention in primary care.

Identifying and prioritizing effective care plans to prevent falls and related injuries is challenging because falls can be caused by different factors, like the effects of certain medications. Dr. Patricia Dykes, a leading researcher on fall prevention, wanted to develop a clinical decision support (CDS) tool that could quickly and easily guide PCPs to the most effective fall prevention strategies for individual patients and engage them in the fall prevention decision-making process. This is critical to ensuring that evidence-based fall strategies are routinely implemented into clinical practice, and patients are able to actively participate in their healthcare to minimize the risk of having a fall.

ASPIRE is a shareable, interoperable CDS tool for fall prevention

Dr. Dykes and her team at Brigham and Women's Hospital and collaborators at University of Florida and UCLA developed a shareable, interoperable, dynamic decision-making tool for community-based fall risk assessment and prevention. The care planning CDS tool—Advancing Fall ASsessment and Prevention

PatIent-Centered Outcomes REsearch Findings into Diverse Primary Care Practices (ASPIRE)—supports PCPs in identifying older adults at risk of falling, as well as supports decision making by linking fall prevention evidence to practice and engaging patients in this process.

> "ASPIRE is based on the data that's already in the electronic health record, for example, if a patient who had ICD codes in the EHR that suggest they had mobility or gait problems. ASPIRE provides decision support for the clinicians and allows them to collaborate with the patient on getting a better assessment of their risk and then informing that tailored or individualized care plan or prevention plan."
>
> **Dr. Patricia Dykes**

ASPIRE is valuable and simple to use

The team conducted interviews, design feedback sessions, and usability sessions with PCPs and older adults to understand their end-user needs. They then pilot tested ASPIRE at two primary care clinics that used different electronic health records. The study showed that the tool helped to engage patients in fall prevention and that the system had value for PCPs around decision making, in discussions with patients, and as a teaching tool. Qualitative feedback from providers indicated that the use of the tool prompted them to make more physical therapy referrals and reminded them to have discussions about high-risk medications, bisphosphonate (medications for treating osteoporosis) use, and exercise. Users also shared that the tool was visually appealing, simple, and quick to use.

The ASPIRE tool is the only tailored fall prevention tool designed for use in primary care, and the team hopes it will be further disseminated and used in other care settings. Because Dr. Dykes and her team developed ASPIRE using informatics standards, the ASPIRE CDS algorithms are shareable and now available on the AHRQ CDS Connect website so others can benefit from this work.

Evaluation of the Scaling Acceptable CDS (SCALED) Approach of Interoperable Clinical Decision Support for Venous Thromboembolism Prevention

A methodology for scaling patient-centered outcomes research into interoperable, shareable clinical decision support tools that are actively maintained with current evidence has the potential to close the evidence-into-practice gap, leading to better patient outcomes.

Shareable clinical decision support: patient-centered outcomes research can translate findings into clinical practice

Recognizing that patients are the best source of information about their needs and preferences, patient-centered outcomes research (PCOR) evaluates questions and results through the lens of what is important to patients and caregivers. Despite agreement that PCOR has the potential to empower patients and improve outcomes, translating PCOR findings into clinical practice is challenging. Interoperable clinical decision support (CDS) tools are an indispensable solution to address this issue, but poor design, lack of interoperability, and implementation barriers hinder adoption. Moreover, the current standard in which each healthcare system develops "home-grown" CDS for the same guidelines is not tenable. Interoperable CDS need to be adaptable to local practice and technology dependencies.

Applying CDS may prevent and treat venous thromboembolism

Patients with traumatic brain injuries (TBI) are at high risk for venous thromboembolism (VTE), a serious condition where a blood clot can develop in the leg or arm and either dislodge or block leg or arm blood flow, causing serious illness, disability, and in some cases, death. But VTE is preventable and treatable if discovered early. To reduce VTE events, patients need preventive care, but guidelines for providing preventive VTE care are only followed about 15 percent of the time in the United States. As a trauma critical care surgeon at the

PRINCIPAL INVESTIGATOR(S)

Christopher Tignanelli, M.D., M.S.

Genevieve Melton-Meaux, M.D., Ph.D.

ORGANIZATION
University of Minnesota

RESEARCH PROFILE
Evaluation of the Scaling Acceptale CDS (SCALED) Approach for the Implementation of Interoperable CDS for Venous Thromboembolism Prevention

FUNDED AMOUNT
$2,937,874

RESEARCH TYPE
Emerging

University of Minnesota, Dr. Christopher Tignanelli wants to use a CDS system to improve adherence with best practices for preventing VTE by "nudging" providers treating patients with TBI. This interoperable system will apply Fast Healthcare Interoperability Resources (FHIR) standards and will be adapted from Dr. Tignanelli's previously developed PCOR CDS tool for COVID-19 VTE prevention. Using the Scaling Acceptable CDS (SCALED) approach, the researchers will evaluate the effectiveness of the adapted CDS tool across four healthcare systems, measuring guideline adherence and rates of VTE.

> "Our goal was, can we develop this decision support system as an app and make it as easy to scale to other hospitals as you would download an app on your phone."
>
> **Dr. Christopher Tignanelli**

Collective efforts support widespread adoption of interoperable CDS

Due to the lack of current robust processes around updating CDS tools as new PCOR evidence emerges, the researchers will also develop and pilot what is referred to as a "Living Guideline" model: a process used to sustain and update evidence-based decision logic. The researchers plan to widely disseminate this new VTE prophylaxis CDS tool for TBI patients to U.S. trauma societies and create an electronic health record-specific 'playbook' focused on rapid integration and implementation of PCOR CDS. Researchers hope these collective efforts will help achieve the goal of widespread adoption of these important CDS tools and address the difficulty of implementing PCOR evidence into medical practice.

Use of Artificial Intelligence to Support Same-Day Breast Cancer Diagnostic Testing

Use of an artificial intelligence algorithm that would allow for screening mammography interpretation and same-day diagnostic imaging has the potential to vastly shorten the time from an abnormal screening mammogram to diagnostic workup, resolving false positives in a timelier fashion, and reducing the anxiety incurred in patients by long wait times for diagnostic evaluation.

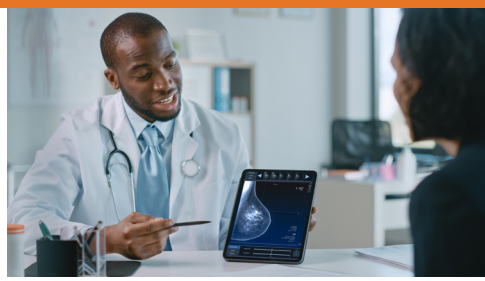
While breast cancer screening can save lives, false positives are common

Mammography screening in the United States has been an incredibly successful tool for identifying breast cancer and has led to a 25-40 percent reduction in breast cancer-related deaths. While most screenings reveal normal results, approximately 10 percent of all screenings require a followup diagnostic exam to confirm a cancer diagnosis. Of women recalled for additional diagnostic exams, roughly 95 percent do not receive a diagnosis of breast cancer.

While this is good news, breast cancer is scary. And the need to return for a diagnostic exam can induce substantial anxiety and distress in women as they wait for their diagnostic appointment and results.

Artificial intelligence will improve time to diagnostic exam

Dr. William Hsu, an informaticist, and Dr. Anne Hoyt, a breast radiologist, both from the University of California Los Angeles, wanted to find a way to speed up the process to reduce patient stress and anxiety. Breast radiologists typically review screening mammograms in batches. This can occur anywhere from the day of the mammogram to more than a week later, depending on workload and staff availability. Identifying abnormal screenings immediately and conducting diagnostic exams on the same day would alleviate patient stress and enable a transformative “one-stop-shop” paradigm for breast cancer screening and diagnosis.



PRINCIPAL INVESTIGATOR(S)

William Hsu, Ph.D.

Anne Hoyt, M.D.

ORGANIZATION
University of California Los Angeles

RESEARCH PROFILE
Using Artificial Intelligence to Support Efficient Same-Day Diagnostic Imaging in Breast Cancer Screening

FUNDED AMOUNT
$1,003,772

RESEARCH TYPE
Emerging

To do this, the team is using artificial intelligence (AI) algorithms at several steps throughout their workflow to immediately interpret screening mammograms and set up same-day diagnostic imaging, if required. This would allow women to undergo their regularly scheduled mammogram and any necessary diagnostic exam on the same day.

> "AI is a tool that can help us to be better radiologists, more efficient radiologists, and ultimately to benefit the patients by finding cancers more quickly and initiate treatment sooner."
>
> **Dr. Anne Hoyt**

Same-day diagnostic exams supported by AI expected to improve care for women

The team will validate various AI algorithms for assessing breast cancer risk and detecting breast cancers on screening mammograms. Using the information on the performance of the AI algorithms, they will investigate how the implementation of an AI-enabled same-day diagnostic exam workflow would impact the number of patients who can be seen at the clinic, the workload of the breast imaging clinic staff, and the number of same-day diagnostic exams that would need to be accommodated. These insights will inform how to integrate the algorithms into clinical workflow to increase efficiency, maximize patient throughput, and promptly communicate results and appropriate next steps to patients while performing at the same level as current radiologist standards. The team expects that imaging centers using AI to provide immediate interpretation of screening exams and same-day diagnostic exams, as needed, will have lower callback rates of women with abnormal screening, increased patient satisfaction from same-day interpretation, and shorter times between screening and diagnostic workup when compared to centers that use the current state of mammography review.

Continuous Predictive Analytics Monitoring to Improve Care for At-Risk Patients with Cardiac Disease

An artificial intelligence digital health tool that identifies patients on the verge of clinical deterioration may allow for faster intervention and a reduction in morbidity and mortality.

Recognizing complications and intervening quickly for hospitalized patients with cardiac disease can improve outcomes

Hospitalized patients with cardiac disease can quickly deteriorate and suffer from sudden complications that can lead to increased morbidity and length of stay, and in some cases, death. These complications can be lessened by early recognition and timely intervention, which is a challenge for healthcare providers who need to be able to identify these patients and allow for earlier clinical action. *"These are patients on acute care floors, not in the ICU, and they unexpectedly get sick. And, so any clinician would tell you that we would want a crystal ball to be able to detect what patients are going [to] get sick unexpectedly,"* said Dr. Jessica Keim-Malpass. *"And as a nurse, I can tell you firsthand that these patients have very insidious symptoms. Often they get sick incredibly quickly before noticeable clinical symptoms and it can have devastating outcomes."*

Continuous monitoring using artificial intelligence and data visualization provides warning signs

While hospitals monitor patients and data, including vitals and labs, Dr. Keim-Malpass wanted to see if continuous predictive analytics monitoring at the bedside—including signals from EKGs captured every 2 seconds to get individual heartbeats and breaths—could warn providers of patients at risk for deteriorating health. The monitoring system gives providers an earlier window of treatment when intervention is most effective.

PRINCIPAL INVESTIGATOR(S)

Jessica Keim-Malpass, Ph.D., R.N.

Jamieson MacDonald Bourque, M.D., M.S.

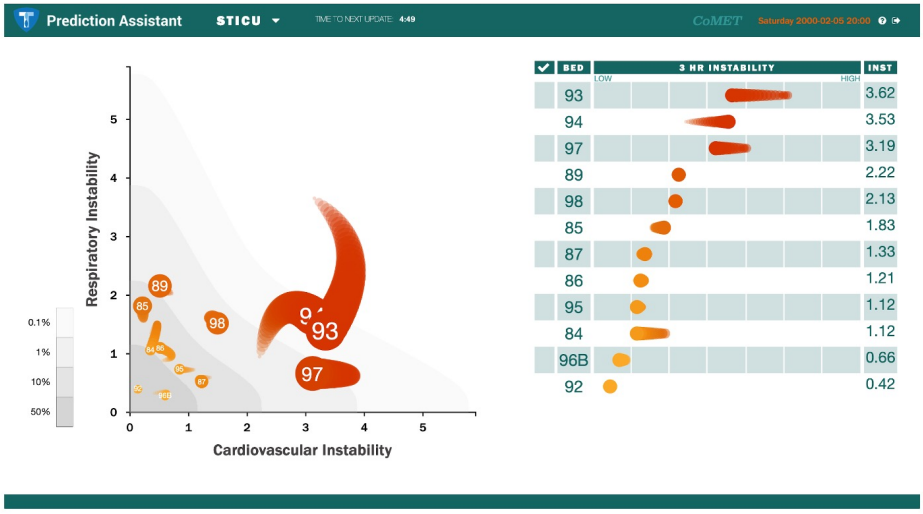
ORGANIZATION
University of Virginia

RESEARCH PROFILE
Predictive Monitoring: IMPact of Real-Time Predictive Monitoring in Acute Care Cardiology Trial (PM-IMPACCT)

FUNDED AMOUNT
$1,200,000

RESEARCH TYPE
Emerging

Drs. Keim-Malpass, Jamieson Bourque, and their University of Virginia team are testing continuous monitoring of event trajectories (CoMET)—an artificial intelligence tool with visual analytics that displays risk estimates for multiple adverse outcomes. The tool integrates data streams of rapidly changing health information to predict and communicate risk of impending decompensation. By shifting the care from reactive to proactive, providers can recognize earlier in the clinical course that a patient is imminently at risk for respiratory failure, sepsis, or hemorrhage, and intervene with appropriate care, resulting in better outcomes.



In a demo of CoMET, Dr. Keim-Malpass explains, *"This tail-to-head, like a comet, represents how the patient's doing in the past 3 hours. You can see for one patient, they started off with moderate risk, and in over 3 hours, they have increased their risk. With the data visualization, your eyes are really meant to be drawn to this patient."*

The clinical information automatically gathered includes readily extracted information in the electronic medical record from the Clinical Data Warehouse, such as numerical values in flow sheets, labs, blood cultures, plus information that is not in the medical record or data warehouse, such as continuous cardiorespiratory monitoring data. A CoMET score is calculated, then displayed (or not displayed) on monitors to draw the clinician's attention to patients warranting early or extra consideration.

Often, the vast quantity of data are difficult for clinicians to absorb in aggregate, an issue compounded with the sickest patients, who generate thousands of datapoints in short periods of time. That is why the creation of visual tools allows for predictive analytics monitoring, while reducing the cognitive load for providers taking care of these patients.

> "All these data are available to clinicians, but anyone would tell you that the level to which algorithms can discern the data and develop risk predictions are certainly way beyond what any human can mentally process and take in."
>
> **Dr. Keim-Malpass**

Earlier recognition of deterioration is beneficial to all

Dr. Keim-Malpass and her team are evaluating the impact of CoMET in a cluster randomized controlled trial to see if its use will draw clinicians' attention to those patients that warrant earlier interventions. While she hopes that the patients will see the biggest benefits, clinicians should also benefit from improved clinical decision making and reduced cognitive burden, as well as reduced costs to the healthcare system overall.

Decision Support in the Emergency Department to Improve Medication Safety for Older Adults

Using the clinical decision support system Enhancing Quality of Prescribing Practices for Older Adults Discharged from the Emergency Department significantly reduces the prescribing of potentially inappropriate medications in the emergency department setting.

PRINCIPAL INVESTIGATOR(S)

Ann E. Vandenberg, Ph.D., M.P.H.

ORGANIZATION
Emory University

RESEARCH PROFILE
Scaling E.Q.U.I.P.P.E.D. Clinical Decision Support

FUNDED AMOUNT
$792,333

RESEARCH TYPE
Completed

Inappropriate ED prescribing puts older adults at risk

Transitions in care, especially when patients are discharged from the ED back to home, can be a risky time for patients, particularly among older adults. More than half of older adults discharged from the ED leave with a new prescription medication. Often, the ED provider does not have full knowledge of a patient's current medication regimen. Full medication review and reconciliation may not occur for several reasons, including the challenge of treating complex patients such as older adults with multiple chronic conditions in a busy ED or clinical decision support (CDS) that is not designed for the ED setting. For older patients, new medications prescribed outside of the primary care setting increases the chance of adverse drug events (ADEs), which can lead to repeat ED visits, hospitalization, or even death. The risk of receiving a new, potentially inappropriate medication (PIM) upon discharge from the ED ranges from approximately 5 percent to 13 percent.

Scaling an effective clinical decision support tool can improve medication safety

Enhancing Quality of Prescribing Practices for Older Adults Discharged from the Emergency Department (EQUIPPED) is a validated CDS tool developed to reduce PIMs prescribed in the ED for adults aged 65 years and older. EQUIPPED CDS includes educational material on clinical guidelines for geriatric prescribing, point-of-care prescribing order sets in the existing electronic health record (EHR), and behavioral reinforcement in the form of monthly audits and feedback with peer benchmarking. Successfully implemented into the Veterans Health Administration's EHR at 20 sites and into

a commercial EHR at three community hospitals, EQUIPPED CDS resulted in a significant and sustained reduction in PIMs prescribed to older adults at ED discharge. Dr. Ann Vandenberg and her team at Emory University implemented EQUIPPED into a new EHR, using the traditional EQUIPPED implementation model, and at three additional sites using a new hub-and-spoke implementation model. By using differing EHRs and implementation models, they sought to further demonstrate EQUIPPED's agility and effectiveness in reducing PIMs across different settings.

> "One of the interesting things we learned was how high some of these potentially inappropriate medication prescribing rates are and uncovered the need to [implement] a tool like EQUIPPED. Across all sites, prescriptions of potentially inappropriate medications reduced after EQUIPPED was implemented, regardless of implementation model."
>
> **Dr. Ann Vandenberg**

EQUIPPED improves safety of prescribing

For the "traditional" site, modeled after previous EQUIPPED implementation efforts, the site adapted and implemented all program components itself. In contrast, the spread sites can be conceived as spokes branching from a hub that had already implemented EQUIPPED. The central hub had the experience and infrastructure in place to deliver education, order sets, and provider feedback reports to a local known champion, who was tasked with delivering provider feedback reports, participating in regular ED meetings, and answering questions. Regardless of the model used or the EHR in place, EQUIPPED proved successful at all sites in significantly reducing prescriptions of PIMs, including two medication classes most problematic for older adults: skeletal muscle relaxants and benzodiazepines. The research showed that EQUIPPED CDS can be successfully and effectively implemented using different implementation models and EHR platforms. If scaled more broadly, it could have profound patient safety impacts by improving medication management and reducing ADEs.

Optimizing Care Delivery for Clinicians: Other Research

The research stories highlighted in this report are only a subset of the work that AHRQ funds. The following table includes additional research related to Optimizing Care Delivery for Clinicians that was either completed or newly awarded in 2022. To search the entire portfolio of research, please visit AHRQ Funded Projects.

Improving medication safety using digital healthcare solutions

Computerized alerts can prevent errors and improve clinical documentation by prompting prescribers to double check the patient, the drug, and the diagnosis whenever a drug being ordered does not match any diagnosis in the patient's problem list.	Access Dr. Lambert's Project Profile
A perioperative clinical decision software platform outperformed the standard medication administration and documentation workflow by improving efficiency and quality of care while receiving higher usability ratings from clinicians.	Access Dr. Nanji's Project Profile
Innovations in drug allergy picklists, particularly using enhanced dynamic picklists, are a promising solution to support real-time allergy reconciliation, improve documentation among providers, and reduce cognitive burden.	Access Dr. Zhou's Project Profile

Scaling effective and interoperable CDS to improve care and decision making

Using interoperable standards to create a reusable, shareable, and scalable system for patient shared decision aids has the potential to scale these important shared decision-making tools widely and improve patient-centered outcomes.	Access Drs. Schilling and Soares' Project Profile
CDS Connect offers a public platform for authoring and sharing interoperable clinical decision support resources. Health information technology developers, clinical informaticists, and healthcare system leaders can leverage each other's experiences and tools to reduce the burden of developing and implementing CDS, thus making it easier overall to advance evidence into clinical practice through CDS.	Access Dr. Fabian's Project Profile
Creating clinical decision support artifacts that are shareable, interoperable, and scalable may allow for wider dissemination of patient-centered outcomes research related guidelines.	Access Dr. Lacson's Project Profile
Clinical decision support embedded within a provider's workflow combined with a continuing medical education program increases a provider's awareness of medications and conditions that increase the risk of Torsades des Pointes, an uncommon, but life-threatening cardiac arrhythmia.	Access Dr. Malone's Project Profile

Scaling effective and interoperable CDS to improve care and decision making (Cont.)

The design, development, and implementation of the app Tapering And Patient Reported outcomes for Chronic Pain Management (TAPR-CPM) led to the identification of strategies, facilitators, and barriers to implementation that provide insight for future digital healthcare interventions.	Access Drs. Miller and Hettinger's Project Profile

Using digital healthcare tools in improving chronic disease care

The use of clinical decision support for adults with prediabetes improves clinical processes and may lead to improved outcomes.	Access Dr. O'Brien's Project Profile
Applying novel machine learning methodologies in real time to readily available risk and prognostic data in electronic health records could contribute to the development of a timely, accurate, and scalable approach to inform personalized childhood asthma treatment at the point of care.	Access Dr. Owora's Project Profile

Using real-time digital healthcare data to improve timely treatment or diagnosis

A clinical decision support system that uses machine learning combined with clinician perspectives to identify and manage patients with acute respiratory distress syndrome is feasible and outperforms clinician recognition.	Access Dr. Gong's Project Profile
Using clinical decision support to alert clinicians about potential factors impacting a patient's ability to adhere with a care plan leads to the improvement of contextualized care plans that account for those factors.	Access Dr. Weiner's Project Profile
Several electronic health record (EHR) communication network structures, including network size and betweenness centralization, impacts patients' survival time such that smaller and more centralized EHR networks are associated with longer survival time.	Access Dr. Zhu's Project Profile

Using technology to improve provider capacity to provide optimal care

A training solution using artificial intelligence can be tailored to allow providers to quickly and actively address inadequate training, and thus improving their ability to elicit from patients their own motivations to make healthy behavior changes.	Access Dr. Hershberger's Project Profile
Examining the relationship between nursing documentation patterns and patient outcomes during the COVID-19 pandemic can support better optimization of electronic health record configurations to support nurses to provide better care for patients.	Access Drs. Rossetti and Yen's Project Profile
The use of order sets in patients with sepsis reduces order variation and improves outcomes and may be a strategy to adhere to best practices and improve clinical management.	Access Dr. Zhang's Project Profile

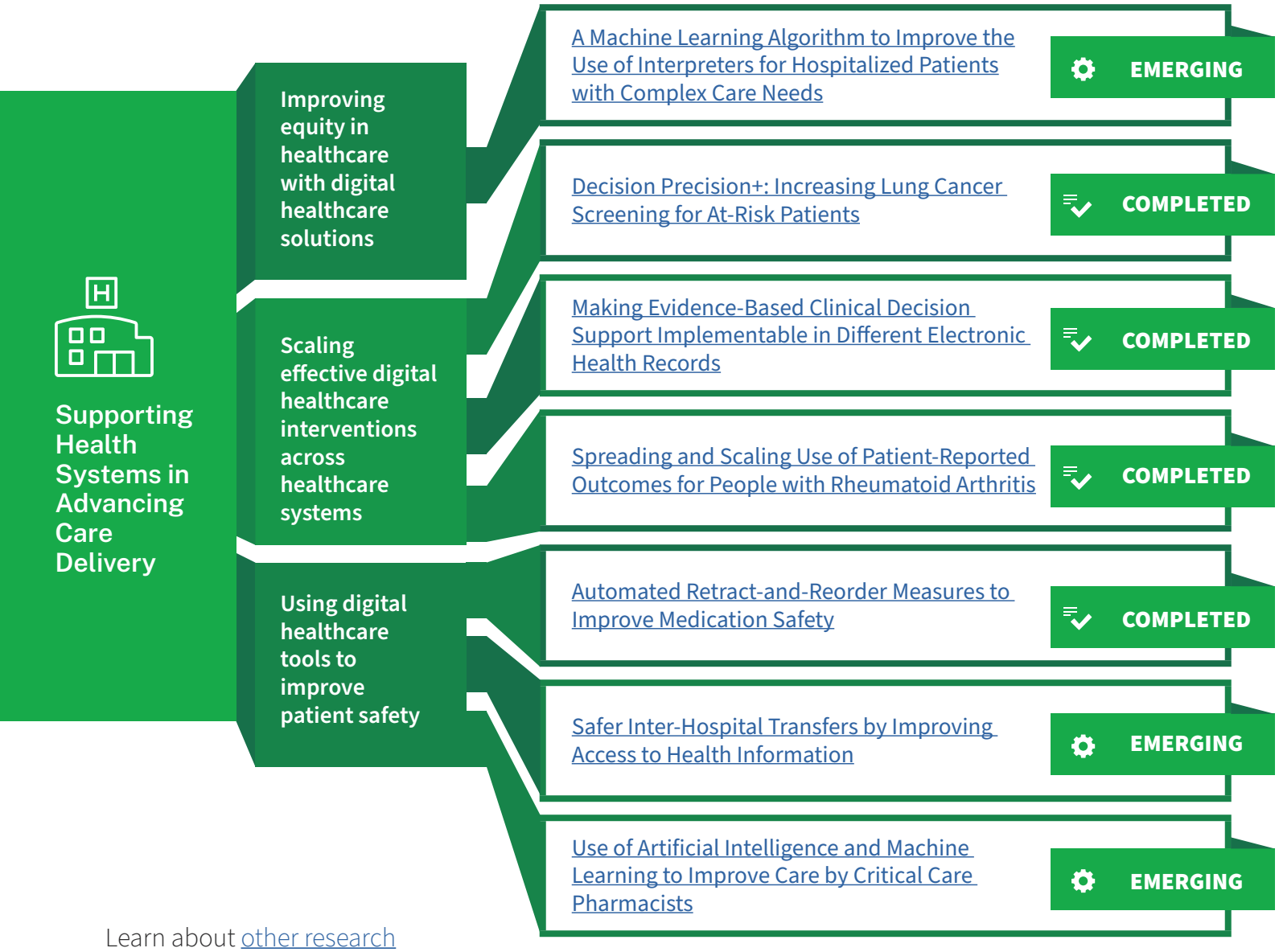
Supporting Health Systems in Advancing Care Delivery

Advancing care delivery at the health systems or organization level, including scaling effective interventions across different platforms, promoting interoperability, and leveraging data and technologies can strengthen healthcare systems and the care they deliver.

In 2022, the DHR program invested $45.4 million across the lifetime of projects on research to advance care delivery and to scale effective digital healthcare intervention across healthcare systems.

Below are research stories told in the investigator's own words that focus on advancing care delivery at the health systems level.

Below are research stories told in the investigator's own words that focus on **advancing care delivery at the health systems level**.



Learn about other research related to this theme.

A Machine Learning Algorithm to Improve the Use of Interpreters for Hospitalized Patients with Complex Care Needs

A machine learning, predictive analytic intervention has the potential to improve healthcare, making it more equitable for patients with a non-English language preference and complex care needs by supporting timely interpreter use to facilitate decision making and promote patient-centered care.

PRINCIPAL INVESTIGATOR(S)

Amelia K. Barwise, M.B., Ph.D.

ORGANIZATION
Mayo Clinic Rochester

RESEARCH PROFILE
Harnessing Health Information Technology to Promote Equitable Care for Patients with Limited English Proficiency and Complex Care Needs

FUNDED AMOUNT
$ 300,000

RESEARCH TYPE
Emerging

In-person interpreters improve communication between patients and their families and providers, supporting more equitable care

For hospitalized non-English language preference (NELP) patients, especially those with complex care needs, communication between patients and their families and inpatient healthcare providers is often difficult, and these communication barriers can lead to lower quality of care, poor health outcomes, and increased length of hospital stay. In-person medical interpretation in a patient's preferred language improves communication, patient satisfaction, and clinical outcomes. Moreover, using in-person interpreters reduces cultural, linguistic, and literacy barriers, supporting more equitable care.

> "Interpreters can help patients and clinicians understand each other and relay information, but they can also help inform the clinicians about potential other background issues that might be important, so clinicians have a better understanding of why decisions are being made, or which people in the family are likely to be important for decision making."
>
> **Dr. Amelia Barwise**

Complex medical conversations are hard, even among English-language preferred speakers

Using in-person interpreters encounters several barriers, beyond the

overall nationwide shortage. Getting an interpreter to the bedside takes substantial coordination and logistics, and some clinical providers are hesitant to engage with that process in busy hospital environments in which they are likely caring for multiple patients. Frequently, providers make do with using family members to interpret or their own limited language skills, but that is not ideal.

> "Families can either not understand all of the medical jargon, so there's the accuracy piece, but then they can also withhold information."
>
> **Dr. Amelia Barwise**

An interpreter is critical to having these conversations, especially as they relate to treatment, end-of-life care or withdrawal of care, or to any other sensitive discussions that are already difficult among English-language preferred speakers.

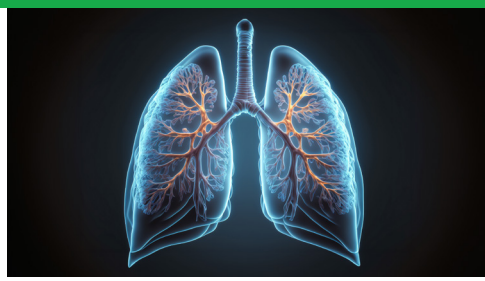
Dr. Barwise and her research team in Mayo Clinic Rochester want to find a better way to identify which patients need an interpreter and prioritize the use of interpreters for these patients. The team is developing machine learning algorithms to reliably identify NELP patients with complex care needs early in their hospitalization.

Use of machine learning algorithms will improve appropriateness and timeliness of using interpreters for patients who need it most

The team is developing the tool with input from clinicians and interpreters to build a process to connect identified patients with timely interpreter services. Once developed, they will integrate the tool into the clinical workflow at Mayo Clinic Rochester and study whether use of the tool increases appropriate and timely interpreter use among NELP patients with complex care needs. In addition to using the tool to identify when to provide an interpreter, they also hope to normalize the use of interpreters to reduce cultural, linguistic, and literacy barriers, and in doing so, support more equitable care.

Decision Precision+: Increasing Lung Cancer Screening for At-Risk Patients

A shared decision-making tool to support the appropriate use of low-dose computed tomography screening has the potential to prevent 10,000 or more lung cancer deaths annually in the United States.



Low-dose computed tomography is an effective but underused tool for identifying lung cancer

Lung cancer is the leading cause of cancer-related deaths in the United States among both men and women. Screening for lung cancer using low-dose computed tomography (LDCT) is effective in early detection of lung cancer among individuals with a history of heavy smoking and is recommended by the U.S. Preventive Services Task Force (USPSTF). And while LDCT could reduce lung cancer deaths by about 20 percent, or more than 10,000 lives per year in the United States, its use is pretty abysmal; less than 10 percent of eligible patients are screened using LDCT every year.

Dr. Kensaku Kawamoto and a group of researchers from the University of Utah, the University of Michigan, and Intermountain Healthcare wanted to find a better way to integrate the potentially life-saving screening into clinical workflows. The team adapted a previously developed standalone shared decision-making tool for lung cancer screening called Decision Precision, which is available at https://screenlc.com. This clinical decision support (CDS) tool incorporates the USPSTF guidelines for LDCT screening and provides patient-specific information on the expected benefits and harms of screening, such as false positives that can result in unnecessary biopsies and possible complications. While standalone web-based CDS tools like Decision Precision may enable clinicians to more easily personalize screening, they are also limited by a lack of workflow integration and often require duplicate data entry, thus increasing provider burden and limiting the tool's usefulness. Further, even when these tools are developed within a specific organization's electronic health record (EHR) system, they can be difficult to disseminate across different health systems and EHR platforms.

PRINCIPAL INVESTIGATOR(S)

Kensaku Kawamoto, M.D., Ph.D., M.S.

ORGANIZATION
University of Utah

RESEARCH PROFILE
Scalable Decision Support and Shared Decision Making for Lung Cancer Screening

FUNDED AMOUNT
$1,184,380

RESEARCH TYPE
Completed

Decision Precision+ is a CDS SMART on FHIR app that improves lung cancer screening

In this followup study, the team adapted Decision Precision into a shareable tool that can be integrated into any EHR system that leverages standards-based interoperability. The new tool, Decision Precision+, is a SMART on Fast Healthcare Interoperability Resources (FHIR) app that pulls data from the EHR to enable providers to have an individualized risk-benefit discussion with at-risk patients on whether lung cancer screening is right for them. The team studied Decision Precision+ in conjunction with EHR prompts to consider lung cancer screening at University of Utah Health primary care clinics. Through this study, they found that rates of lung cancer screening orders and completion increased remarkably for eligible patients.

> "We found that the DP+ and the EHR prompts had a pretty substantial impact. Our rate for screening orders for eligible patients as well as patients getting actually screened both increased over threefold. And in a clinical space, that's considered pretty substantial because we typically see a 5 to 10 percent increase. So, an over 300 percent increase is quite promising."
>
> **Dr. Kensaku Kawamoto**

Additional research is improving and scaling DP+

Decision Precision+ is now offered to healthcare organizations as a free tool that can be downloaded and used within any EHR system that supports the SMART on FHIR framework. Already, adoption of the CDS tool is in process with multiple healthcare systems. In addition, Dr. Kawamoto has received followup funding from AHRQ to further improve DP+ and promote real-world dissemination and implementation of the tool. The followup research is using a user-centered design approach to supplement DP+ with a patient-facing SMART on FHIR application called MyLungHealth. The app integrates with patient portals and can be used directly by patients so they can learn about lung cancer screening and review their individualized estimates of the benefits of screening. In addition, the researchers are studying how best to help other health systems implement these tools and developing self-service resources to assist with implementation. By doing so, this research will widely disseminate patient-centered tools to help improve lung cancer screening at scale and reduce lung cancer deaths.

Making Evidence-Based Clinical Decision Support Implementable in Different Electronic Health Records

Clinical decision support that can be implemented in different types of electronic health records has the potential to scale evidence-based practice across healthcare systems.

Scaling evidence-based clinical decision support for serious conditions is difficult

Venous thromboembolism (VTE)—a condition that occurs when a blood clot forms in a vein—includes both deep venous thrombosis (DVT) and pulmonary embolism (PE) and can lead to death or disability if not caught early and treated. While there are effective evidence-based clinical prediction rules for assessment of VTE that have been integrated into clinical decision support (CDS) tools, it is often difficult to scale these tools across organizations and electronic health record (EHR) platforms.

EvidencePoint is an EHR-independent CDS platform

To support early detection and treatment of VTE, Drs. Alex Spyropoulos and Thomas McGinn and their team at the Northwell Health Center for Health Innovations and Outcomes Research developed an EHR-independent CDS software platform called EvidencePoint. This platform provides a suite of individual CDS solutions capable of being integrated into clinical workflows within various EHRs at various clinical sites without requiring the solutions to be "rebuilt" for each deployment. As Dr. Spyropoulos describes, *"The beauty of this platform is that it was developed as EHR agnostic. If it works for one EHR, it should work for any EHR."*

The research team deployed and tested three CDS applications using the platform: 1) the Northwell COVID-19 Survival (NOCOS) CDS application, which was tested among patients with and without COVID-19; 2) the International Medical Prevention Registry on Venous Thromboembolism-D-Dimer (IMPROVE-DD) CDS application for VTE risk assessment; and 3) the Wells' Criteria CDS application for PE diagnosis risk stratification.

PRINCIPAL INVESTIGATOR(S)

Alex Spyropoulos, M.D.

Thomas McGinn, M.D., M.P.H.

ORGANIZATION
Feinstein Institute for Medical Research

RESEARCH PROFILE
Implementation of a Novel Multi-Platform Evidence-Based Clinical Decision Support System

FUNDED AMOUNT
$1,541,803

RESEARCH TYPE
Completed

When the COVID-19 pandemic hit in spring 2020, they were able to quickly deploy the NOCOS CDS across all Northwell hospitals, where it was available for easy access to providers in the ED directly through the EHR. In December 2020, they launched a clustered randomized trial and deployed the IMPROVE-DD CDS application for VTE risk assessment to two of Northwell's largest tertiary hospitals, where it was configured as a mandatory component of the VTE prophylaxis process for all hospitalized patients. Two similarly sized hospitals were randomized to serve as controls (i.e., no CDS application). Over the course of a 1-year study, the application was used with 5,249 unique patients at the intervention sites.

In September 2021, they deployed the Wells' Criteria CDS application for PE diagnostic risk assessment to the same two tertiary hospitals that were using the IMPROVE-DD application. One hospital used the Wells' Criteria application with a standard user interface. The other hospital added a feature in the user interface that offered a nudge designed to increase user adoption of the tool. Over the course of a 6-month pilot study, the application was used during 1,735 patient encounters.

CDS use improved across the platform

Appropriate thromboprophylaxis rates were higher at intervention sites using IMPROVE-DD during inpatient stays and after discharge, and had fewer venous, arterial, and total thromboembolic events. The study also found that the IMPROVE-DD VTE risk assessment model demonstrated very good discrimination to identify hospitalized COVID-19 patients at low, moderate, and high VTE risk.

> "What we saw was a 50% relative increase in appropriate in-hospital prophylaxis when comparing the intervention group that used the tool with the control group that did not use the tool."
>
> **Dr. Alex Spyropoulos**

At the ED site where the Wells' Criteria PE diagnostic risk assessment with nudges was deployed, providers followed the tool's CDS recommendations 46.3% of the time, compared with a 23.2% at the ED that used the standard, no-nudge version of the tool.

This virtual doubling of provider adoption is an indication that nudges have the potential to dramatically increase CDS adoption rates. However, the use of the Well's Criteria was found to not differ significantly in ruling out PE in COVID-19-positive versus -negative patients.

Ultimately, the research accomplished an important goal of furthering the dissemination of evidence-based practices at the point of care. By demonstrating the feasibility of a workflow-integrated CDS platform that can be used in different EHRs, the team has shown the value of these CDS applications in the short term (the NOCOS app, the IMPROVE-DD app, and the Wells' Criteria app). The team also developed a system that is capable of bringing those applications, and others, to health systems beyond Northwell Health.

Spreading and Scaling Use of Patient-Reported Outcomes for People with Rheumatoid Arthritis

Development of a toolkit to facilitate the scale and spread of using patient-reported outcomes among rheumatoid arthritis patients fills an existing gap in national resources to provide support to rheumatologists.

PRINCIPAL INVESTIGATOR(S)

Jinoos Yazdany, M.D., M.P.H.

ORGANIZATION
University of California, San Francisco

RESEARCH PROFILE
Rheumatology Informatics System for Effectiveness Patient-Reported Outcome (RISE-PRO) Dissemination Project

FUNDED AMOUNT
$1,480,915

RESEARCH TYPE
Completed

Using patient-reported outcomes is effective, but often underused, in ongoing management of rheumatoid arthritis

Over one million Americans have rheumatoid arthritis, a condition that causes pain and swelling in the joints, fatigue, and profound joint stiffness. Over time, inflammation can cause joint deformities and impair physical functioning, significantly impacting a person's quality of life. Routine measurement and monitoring of patient-reported outcomes (PROs), including symptoms of physical functioning, is effective in helping clinicians and patients monitor symptoms and make treatment decisions.

A wide body of evidence and guidelines from the American College of Rheumatology (ACR) supports using PROs to help clinicians monitor rheumatoid arthritis and to help patients track their progress on treatment. Nevertheless, the use of PROs is inconsistent, with some practices not collecting them at all. Dr. Jinoos Yazdany, a practicing rheumatologist, wanted to change that: *"We have a long history of using PROs in rheumatoid arthritis. They're validated and feasible to use. Patients want their doctors to use and discuss PROs. The next important hurdle is to cross the implementation divide by getting people to consistently use them in a way that both doctors and patients find meaningful."*

Clinical learning network supports use of PROs for patient care

Teaming with the ACR, Dr. Yazdany convened a clinical learning network, with a focus on public hospital systems, to advance PRO measurement and use in rheumatology practices. The network committed to answering the question: "How can PROs be collected

and used in a patient-centered way to improve outcomes for rheumatoid arthritis at every clinical encounter?" Participating groups used Plan-Do-Study-Act cycles to test and improve workflows and shared feedback and lessons learned with the group. The learnings from the group were incorporated into a toolkit for national dissemination, described below.

A second goal of the project was to address one of the biggest challenges for using PROs at the point of care: the fact that much of the information is buried in clinical notes in electronic health records (EHRs). Dr. Yazdany and her team at the University of California San Francisco worked with computer scientists at Stanford University to develop and validate a natural language processing (NLP) system. This NLP system reliably extracted PROs from clinical notes in more than 300 rheumatology practices, representing over 40 EHR systems that participate in the RISE registry, an EHR-based Qualified Clinical Data Registry that comprises 3 million people with rheumatic diseases. To support national dissemination, the NLP algorithm is publicly posted on GitHub.

> "We only see patients for 1% of their lives, and so allowing them to actually have data and tools to manage their own disease in between visits, which is the rest of the 99%, is really important."
>
> **Dr. Jinoos Yazdany**

Network shares what they learned to scale use of PROs

Among the key findings of the learning network were that patients and clinicians were generally motivated to collect PROs, and clinicians wanted practical tools to be able to implement the PROs in their practices. Using data gathered from the learning network as well as extensive qualitative interviews from rheumatology practices around the country to learn best practices for PRO collection, the team opted to package learnings from the project into a toolkit to facilitate the scale and spread of rheumatoid arthritis (RA) PROs across practices. The toolkit—freely available on the ACR website—

should fill a gap in national resources to provide support in this area to rheumatologists.

The RA Toolkit includes resources on: how to select the appropriate PROs to use; tips for using PROs to succeed in Federal quality reporting programs like the Merit-Based Incentive Payment System; how to develop efficient workflows for collecting rheumatoid arthritis measures (e.g., PRO collection for in-person versus telehealth); considerations for PRO collection in diverse populations, including non-English speaking populations; case studies describing practices with high performance on PRO-based quality measures; how to benchmark PRO quality measures through the RISE registry; and a nursing staff training guide about effective collection of PROs in practice.

Automated Retract-and-Reorder Measures to Improve Medication Safety

New measures to identify near-miss medication errors are a major advancement in patient safety and can help healthcare systems make ordering even safer.

PRINCIPAL INVESTIGATOR(S)

Jason Adelman, M.D., M.S.

ORGANIZATION
Columbia University Health Sciences

RESEARCH PROFILE
Develop and Validate Health IT Safety Measures To Capture Violations of the Five Rights of Medication Safety

FUNDED AMOUNT
$999,997

RESEARCH TYPE
Completed

Near-miss medication errors are difficult to identify and are underreported but can be opportunities to make electronic ordering safer

Medication errors are the most common and preventable cause of patient harm. Yet efforts to prevent these errors have been hampered by lack of standardized measures. Near-miss medication errors, such as when clinicians realize they've ordered the wrong dose or frequency for a drug, are caught before the error ever reaches the patient. Although patient harm may have been avoided, understanding the circumstances surrounding near-miss errors presents opportunities to improve safe ordering practices. Research on electronic ordering systems and processes can provide insight into contributors to medication errors, as well as insight into potential solutions.

In previous research, Dr. Jason Adelman of Columbia University developed and validated the automated Wrong-Patient Retract-and-Reorder (RAR) Measure to identify wrong-patient electronic orders. The Wrong-Patient RAR measure identifies orders placed for a patient that are retracted within 10 minutes, and then placed by the same clinician for a different patient within the next 10 minutes. These near-miss errors are self-caught by the clinician before they reach the patient. The Wrong-Patient RAR measure enabled systematic and objective identification of wrong-patient orders in electronic health record (EHR) data, resulting in a critical breakthrough in patient safety research. As Dr. Adelman noted, "Before the development of the Wrong-Patient RAR measure, there were [approximately] six voluntary reported wrong-patient order errors each year at NewYork-Presbyterian versus 10,000 errors identified in a year after the Wrong-Patient RAR measure was implemented. You can't study errors and improve systems when there are only six events."

Expanding the RAR methodology to other medication order errors further improves understanding and safety

Based on this pioneering work, Dr. Adelman wanted to expand RAR measures to medication and other types of order errors. Using the RAR methodology, Dr. Adelman and his team developed new measures to capture instances where an order was placed, retracted by the ordering clinician, and subsequently reordered by the same clinician for the same patient with a parameter of the order changed. These measures identify electronic order errors including wrong dosage, wrong route, wrong frequency, or wrong medication.

A unique aspect of the research is that the team was able to query for RAR events every 30 minutes and then contact clinicians within 6 hours of each RAR event to understand what happened, including why the initial order was placed, why the order was canceled, who prompted the cancelation, and why the medication was reordered with a parameter changed (e.g., dose, frequency, route). This allowed the researchers to classify whether the event was a true error or not, and to better understand contributing factors for these different errors.

> "This research allows us to examine the epidemiology of these errors and identify targets for intervention. Are there differences in frequency by type of errors, for example, wrong-patient versus wrong-dose errors? Are there differences by shift, for example, when you're tired at night versus during the day? Are there differences between attendings and house staff? You can get very accurate data without the biases of chart review or voluntary reporting."
>
> **Dr. Jason Adelman**

RAR measures help identify errors and test interventions to prevent them

The RAR measures were studied at seven hospitals with over 3,000 inpatient beds and six emergency departments with two different EHR systems. The team validated the measures by calculating their positive predictive value (PPV), which tests how well the measures

detected true errors. All measures achieved a high PPV, reaching the target of greater than 75 percent. The research showed that automated measurement of electronic order errors can be readily integrated into health system EHRs to study the epidemiology of order errors and to test the effectiveness of proposed EHR improvements on order error outcomes. Dr. Adelman and his team will publicly share the specifications for the RAR measures developed in this study so that the measures can be readily and widely used by other healthcare systems.

Safer Inter-Hospital Transfers by Improving Access to Health Information

An enhanced health information exchange platform that improves workflow, interoperability, and visualization of data for inter-hospital transfers may reduce the morbidity and mortality seen today during inter-hospital transfers.

PRINCIPAL INVESTIGATOR(S)

Stephanie Mueller, M.D., M.P.H.

ORGANIZATION
Brigham and Women's Hospital

RESEARCH PROFILE
Advancing Health Information During Inter-Hospital Transfer to Improve Patient Outcomes

FUNDED AMOUNT
$1,981,506

RESEARCH TYPE
Emerging

A better transition improves patient safety

Inter-hospital transfer is a common occurrence among patients with multiple chronic conditions who need specialized care not available in the transferring hospital. Such patients are routinely transferred between different clinical providers, hospitals, or healthcare systems. While critical to meeting the needs of patients, inter-hospital transfers can result in errors that reduce patient safety due to the lack of continuity of care. Communication and information exchange gaps are frequent during inter-hospital transfer, which can lead to poor patient outcomes. Dr. Stephanie Mueller and her team at Brigham and Women's Hospital recognize the vulnerabilities that can happen with the transfer of care for patients with chronic conditions and want to address health information exchange gaps during these transfers.

Communication is key for successful transfers

Building on their prior extensive research in inter-hospital transfer and health information technology innovation, Dr. Mueller and her research team are developing an interoperable platform to improve communication and access to clinical information for patients undergoing inter-hospital transfers. Using a user-centered design approach, this platform will identify essential clinical information in the originating hospital's electronic health record (EHR) and optimize data visualization for clinicians involved in receiving patient transfers. The team will design the platform for three use cases during inter-hospital transfer, including patients transferred from hospitals within the same health system, hospitals in different systems with a common EHR, and hospitals in different systems with different EHRs. An evaluation of the platform will examine its impact on patient safety outcomes, such as medical errors and adverse events; its

clinical use and perceived usability; and any facilitators and barriers to use from those who interact with the platform.

> "Our hope is to develop and successfully implement a platform that improves information exchange of necessary clinical information that clinicians need to access to be able to safely care for patients at time of transfer. This platform is going to be user-friendly and accepted by frontline users because it's being developed and implemented with their input from the forefront."
>
> **Dr. Stephanie Mueller**

Patient safety must come first

The inter-hospital transfer platform has the potential to increase access to data for clinicians during transfers and ultimately improve safety for patients. Additionally, by leveraging existing data exchange standards and implementing the platform in various use cases, the platform should be easily adopted and able to scale across an organization and to other similar organizations. In the last year of the study, the team will develop a toolkit to support widespread dissemination and adoption. Overall, Dr. Mueller and her team hope that the lessons learned will inform successful and sustained adoption by other health care systems, thus broadly improving care provided to transferred patients.

Use of Artificial Intelligence and Machine Learning to Improve Care by Critical Care Pharmacists

Using machine learning- and artificial intelligence-developed tools in the ICU has the potential to optimize critical care pharmacist resources and improve patient safety by reducing adverse drug events.

PRINCIPAL INVESTIGATOR(S)

Andrea Sikora, Pharm.D., M.S.C.R.

ORGANIZATION
University of Georgia

RESEARCH PROFILE
Machine Learning Validation of Medication Regimen Complexity for Critical Care Pharmacist Resource Prediction

Artificial Intelligence-Based Health Information Technology Tools to Optimize Critical Care Pharmacist Resources Through Adverse Drug Event Prediction

FUNDED AMOUNT
$2,156,598

RESEARCH TYPE
Emerging

Critical care pharmacists have the expertise to handle patients that have complex medical needs

In intensive care units (ICUs), critical care pharmacists (CCPs) are integral members of healthcare teams. CCPs analyze and manage the highly complex medication regimens of ICU patients and work to identify and provide guidance for medication-related problems. Research shows that having a pharmacist on rounds in the ICU has significant benefits, including reduction of medication errors and adverse drug events (ADEs), improved patient outcomes, reduced costs, and most importantly, reduced risk of death by 20 percent.

But access to these pharmacists in the United States is lacking. Not all ICUs have CCP care and even when they do, the CCP is often caring for many patients—up to 50 or more at a time. This leads to high cognitive load and difficulty effectively managing time to provide for the patients most in need of CCP care.

As a CCP herself, Dr. Andrea Sikora sees firsthand how ICU patients benefit from having a CCP on the care team. With two recently awarded AHRQ-funded grants, she is studying the challenges that can be created by these gaps in CCP care and availability and how technology can better support their work to improve patient-centered outcomes.

Implementing a tool can quantify the complexity of a patient's medication regimen and predict potential ADEs

In the first study, Dr. Sikora and her team at the University of Georgia are using artificial intelligence and machine learning to create algorithms for predicting which patients are at risk for ADEs based on

patient features, opportunities for intervention, and those associated with poor outcomes. The tool, called the Medication Regimen Complexity Intensive Care Unit, or MRC-ICU score, quantifies the complexity of a patient's medication regimen to predict ADEs that could be prevented by timely CCP intervention. The tool will be integrated into visualization dashboards, called ICView, that guide CCPs in preventing ADEs in patients, thus improving patient safety.

Using machine learning may help predict when pharmacists are needed for critical care

In the second research study, the team plans to develop and validate machine learning predictive models to optimize the workflow for CCPs by identifying which patients need CCP intervention. The models will be integrated into the MRC-ICU tool and will summarize CCP workload through predicting total CCP interventions. The models will also guide CCP care by predicting ADEs that may be prevented by CCP intervention. Identifying which interventions—and under which conditions—can improve outcomes by helping administrators better determine workload, such as optimal CCP-to-ICU ratios through providing workload insights.

> "That tool quantifies the complexity of what the patient is taking in the ICU with the goal that it's going to help predict how much effort you need from a pharmacist. If you knew that, then you could say, 'Okay, this patient needs an hour of effort, and we have 20 patients in the ICU.' Well, that's 20 hours, so that is probably more than one 8-hour shift. And so, you'd be able to have those kinds of conversations around workload."
> **Dr. Andrea Sikora**

Collectively, Dr. Sikora's innovative AHRQ research shows the exciting ways that machine learning and artificial intelligence can be used in healthcare. In addition to benefiting patients by facilitating CCPs interventions when medication-related problems are found, the research can benefit the healthcare system at large by providing the justification for the critical role that CCPs play.

Supporting Health Systems in Advancing Care Delivery: Other Research

The research stories highlighted in this report are only a subset of the work that AHRQ funds. The following table includes additional research related to Supporting Health Systems in Advancing Care Delivery that was either completed or newly awarded in 2022. To search the entire portfolio of research, please visit AHRQ Funded Projects.

Improving equity in healthcare with digital healthcare solution

Bringing together States' Medicaid medical directors to understand undiscovered challenges facing Medicaid consumers and Medicaid programs in identified areas that may be amenable to improvement through technology innovation.	Access Ms. Kennedy's Project Profile
The use of automated speech recognition and automated machine translation technologies integrated in an asynchronous telepsychiatry application may be a viable language interpretation option for those with limited English proficiency.	Access Dr. Yellowlees' Project Profile

Scaling effective digital healthcare interventions across healthcare systems

The dissemination of a low-cost, user-friendly, culturally competent, evidence-based, scalable intervention to improve the health of young African American women is critical to improving maternal and child health outcomes.	Access Dr. Jack's Project Profile
Improving shared decision making for lung cancer screening by adapting and disseminating an interoperable clinical decision support tool and patient-facing app has the potential to reduce lung cancer deaths—the leading cause of cancer-related deaths in the United States.	Access Dr. Kawamoto's Project Profile
E-care plan applications that use interoperability standards have the potential to improve care management and care coordination for people with multiple chronic conditions across different healthcare settings.	Access Dr. Marcial's Project Profile

Scaling effective digital healthcare interventions across healthcare systems

Applying improved methods to handle missing and misclassified data across databases without the need to share data on the individual level will lead to improvements in data used for population-level research.

Access Dr. Toh's Project Profile

Creating tools to automate the assessment and improvement of representational semantic integrity of terminologies in electronic health record databases will lead to improved databases with less redundancy and ambiguity and more robustness for research purposes.

Access Drs. Zeng and Nelson's Project Profile

Using digital healthcare tools to improve patient safety

Analyzing electronic health record metadata may help health systems identify gaps, inconsistencies, and inefficiencies in discharge planning to inform improvements in transitions of care.

Access Dr. Cross' Project Profile

Research Dissemination

The dissemination of DHR-funded research findings is critical to the transfer of successful digital healthcare knowledge, tools, and strategies that improve healthcare delivery, optimize clinician decision making, and engage patients and caregivers.

Throughout the year, DHR-funded researchers and staff showcase their research findings in peer-reviewed journals, at health- and informatics-focused conferences, and during AHRQ national webinars. These dissemination activities highlight the importance of DHR program funding in advancing digital healthcare and improving the health of the American people.

AHRQ-Funded Researchers Disseminate Findings in High-Impact Journals

In 2022, DHR-funded researchers published over 100 research articles in peer-reviewed journals and book chapters. The following were published in high-impact journals and/or highly cited in the research community:

Challenges and opportunities for advancing patient-centered clinical decision support: findings from a horizon scan.

Dr. Prashila Dullabh and co-authors, including DHR team members Dr. Chris Dymek and James Swiger, describe their research on identifying challenges to the development of patient-centered clinical decision support and outlining the opportunities to advance its development. Through a technical expert panel, scoping literature review, and key informant interviews, the researchers identified 12 challenges for patient-centered clinical decision support development, including lack of patient input, lack of patient-centered terminology standards, and limited attention to patients' and providers' concerns. The paper then outlines the researchers' recommendations to optimize patient-centered clinical decision support development at all stages of development.

Nothing for me or about me, without me: codesign of clinical decision support.

Authors Dr. Lacy Fabian and DHR team member Dr. Edwin Lomotan describe their case study on how two patient activists successfully implemented models for engaging patients and caregivers in a

Federal program designed to increase the uptake of research evidence into clinical practice through clinical decision support. These models included virtual focus groups, social media, agile software development, and attention to privacy and cybersecurity.

Primary care telemedicine during the COVID-19 pandemic: patient's choice of video versus telephone visit.

Dr. Mary Reed describes her research on what characteristics are associated with patients' choice of video versus telephone telemedicine during the COVID-19 pandemic. Patients of Black or Hispanic race/ethnicity or living in low socioeconomic status or low internet access neighborhoods were less likely to schedule video visits, while patients 65 years or older, with prior video visit experience or mobile portal access, or visiting their own personal provider were more likely to schedule video visits. While video adoption was substantial in all patient groups examined, differences in telemedicine choice suggest the persistence of a digital divide, emphasizing the importance of maintaining a telephone telemedicine option.

AHRQ Digital Healthcare Research Publications Database

See where AHRQ-funded research has been published.

Reaching the Research Community Through Webinars

The DHR Program sponsors national webinars showcasing the latest scientific advancements and key conversations with experts around impactful research in the evolving digital healthcare ecosystem. These events give DHR-funded researchers the opportunity to discuss their work with a broad and interested audience from around the world.

The February 22, 2022, webinar Transforming Healthcare through Patient-Generated Health Data Integration featured the following DHR-funded research:

- Dr. Deborah Cohen presented on the process of developing an evidence-based practical guide on integrating patient-generated health data (PGHD) for ambulatory care practices. The guide is meant to support ambulatory practices, in partnership with patients, to navigate the steps from design, to launch, to maintenance of a successful, sustainable PGHD integration program that can improve patient outcomes.
- Dr. Ida Sim showcased the Mobile Patient-Reported Outcomes for Value and Effectiveness (mPROVE) tool, which collects and shares patient-reported outcomes in a primary care setting for a diverse patient population with multiple chronic conditions. The tool aims to improve patient self-management while informing providers of patients' health experiences and enabling patient-centered shared clinical decision making.
- Dr. Leslie Lenert described his work on intimate partner violence (IPV) screening and care. His team is designing, implementing, and evaluating a set of tools in an electronic health

record (EHR), including embedded self-reported questionnaires, clinical decision support for IPV screening and detection, telehealth referrals to national counseling services, and EHR modifications to support billing for IPV services.

The June 15, 2022, webinar Improving Diagnosis and Treatment of Adult Depression Through Digital Healthcare featured the following DHR-funded research:

- Dr. Neda Laiteerapong showcased research on how to screen for depression via a patient portal and compared that approach to standard care. Findings from her research showed that using a patient portal in between medical appointments significantly increases the number of patients screened and treated for depression.
- Dr. Carolyn Turvey highlighted her research on ConnectCare, a depression intervention that combines depression-specific patient portal features and the ability to communicate with a provider to increase patient activation, promote collaborative evidence-based decision making, support treatment adherence, and reduce depressive symptoms.
- Dr. Adrian Aguilera presented the Diabetes and Mental Health Adaptive Notification Tracking and Evaluation (DIAMANTE) study. His team implemented and evaluated an adaptive-learning, clinic-integrated, mobile intervention targeting physical activity to manage diabetes and depression in low-income minority patients. Machine learning algorithms adapted and delivered health messages via text messaging to motivate individuals based on their needs.

The October 19, 2022, webinar Optimizing Data Visualization to Improve Care featured the following DHR-funded research:

- Dr. Gabriela Schmajuk showcased research on developing and implementing an electronic dashboard to display patient-reported outcomes (PROs) at the point of care to facilitate conversations between clinicians and patients with rheumatoid arthritis (RA). Incorporating real-time, easy-to-interpret visualizations of PRO data into clinical encounters has the potential to increase patient engagement and shared decision making, and is hypothesized to improve health outcomes and reduce disability for patients with RA.
- Dr. Richelle J. Koopman presented on the design and testing of a data visualization tool of both home- and clinic-derived blood pressure data as a clinical decision support tool. Patients and clinicians used the data to better understand hypertension control and inform shared treatment decisions. The data visualization specifically addressed human factors to create improved meaning for patients and physicians and ease cognitive load.
- Dr. Daniel C. Malone highlighted his work on preventing drug interactions through patient-centered shared decision making. This research developed a dashboard called DDInteract, which graphically communicates risks and decision options around gastrointestinal bleeding. DDInteract was positively received by both patients and physicians and found to be more logical, effective, easy to use, and valuable, compared to traditional drug interaction tools.

Disseminating Knowledge and Research Findings at Conferences

DHR-funded researchers and staff presented research findings at a variety of digital healthcare, health services research, medical, and other conferences. These included the Annual Symposium for the American Medical Informatics Association (AMIA), AcademyHealth's Annual Research Meeting, the Human Factors and Ergonomics in Health Care Annual Symposium, the American Telemedicine Association Annual Meeting, the Society of Medical Decision Making, and the Health Information Management Systems Society's Global Conference and Exhibition.

At the 2022 AMIA Annual Symposium alone, AHRQ-funded research was highlighted in 19 sessions and demonstrations. Click on the links in Table 1 to learn more about this research.

Table 1: AHRQ-Funded Research at the 2022 AMIA Annual Research Symposium

AHRQ Principal Investigator	AHRQ-Funded Research Profile	AMIA Session
Melissa Burgermaster (PI)	Clinical Decision Support for Collaborative Diet Goal Setting in Primary Care	Presentation: A Behavioral Science-Based Clinical Decision Support System for Chronic Disease Management
Anuj Dalal (PI), Kaitlyn Konieczny (presenter)	Real-Time Symptom Monitoring Using ePROs to Prevent Adverse Events During Care Transitions	Poster: Augmenting an Electronic Chart Review Tool for Post-Discharge Symptom Monitoring and Adverse Event Determination
Prashila Dullabh (PI), James Swiger (presenter, AHRQ)	Patient-Centered Outcomes Research Clinical Decision Support: Current State and Future Directions	Panel: Future Directions for Patient-Centered Clinical Decision Support: What Have We Learned and Where Do We Go Next?
Maya Gerstein (AHRQ)	N/A	Poster: Examining Stakeholder Perspectives on the Development, Implementation, and Measurement of Clinical Decision Support-Based Interventions for Shared Decision Making
Christopher Harle (PI)	Designing User-Centered Decision Support Tools for Chronic Pain in Primary Care	Poster: A Multidisciplinary System Design Workshop to Adapt Interoperable Clinical Decision Support Tools for Chronic Pain

AHRQ Principal Investigator	AHRQ-Funded Research Profile	AMIA Session
Sharon Hewner (PI), Roland Gamache (AHRQ)	Implementing Personalized Cross-Sector Transitional Care Management to Promote Care Continuity, Reduce Low-Value Utilization, and Reduce the Burden of Treatment for High-Need, High-Cost Patients	Workshop: Examining Implications and Use of Social Determinants of Health Data
Kensaku Kawamoto (PI), Roland Gamache (AHRQ)	Scalable Decision Support and Shared Decision Making for Lung Cancer Screening	Panel: Establishing a Multidisciplinary Initiative for Interoperable EHR Innovations at an Academic Medical Center: the University of Utah ReImagine EHR Experience
David Kaufman, Yalini Senathirajah (co-PIs)	Evaluating and Enhancing Health Information Technology for COVID-19 Response Workflow in a Specialized COVID-19 Hospital in a Medically Underserved Community	Poster: Assessing Pandemic Readiness to Promote Equity in Institutional Health IT
Kathy Mikk (PI), Edwin Lomotan (presenter, AHRQ)	CEPI Evidence Discovery And Retrieval (CEDAR) Project	Systems Demonstration: CEDAR: FAIR Clinical Evidence in Action
Kathy Mikk (PI), Kimberly Albero (presenter), Edwin Lomotan (presenter, AHRQ)	CEPI Evidence Discovery And Retrieval (CEDAR) Project	Panel: Need FAIR Evidence? Use CEDAR to Discover and Retrieve Research Findings
Daniel Malone (PI), Thomas Reese (presenter)	Enabling Shared Decision Making to Reduce Harm from Drug Interactions: An End-to-End Demonstration	Poster: Evaluation of Shared Decision-Making for Concomitant Warfarin and NSAID Medications Using the DDInteract App

AHRQ Principal Investigator	AHRQ-Funded Research Profile	AMIA Session
Kristen Miller, Aaron Zachary Hettinger (co-PIs), Robin Littlejohn (presenter)	Clinical Decision Support for Chronic Pain Management	Poster: Opioid Tapering Application Pilot: Strategies, Facilitators, and Barriers to Implementation of a Clinical Decision Support Solution for Chronic Pain Management
Karen Nanji (PI)	Preventing Perioperative Medication Errors and Adverse Drug Events Through the Use of Clinical Decision Support	Systems Demonstration: A Real-Time Perioperative Medication Safety Software Platform
Sripriya Rajamani (PI)	Advancing Population and Public Health Reporting and Outcomes with Vaccination Data Exchange (APPROVE)	Poster: Evolution of Electronic Exchange of Public Health Vaccination Reporting and Queries in COVID-19 Context: Minnesota Immunization Information System
Sarah Rosetti (PI), Amanda Moy (presenter)	Essential Nurse Documentation: Studying EHR Burden During COVID-19 (ENDBurden)	Presentation: Reaching an Immersed Flow State: Studies of EHR Workflows
Robert Rudin (PI), Jorge Sulca Flores (presenter)	Integrating Patient-Reported Outcomes Into Routine Primary Care: Monitoring Asthma Between Visits	Poster: Analysis of Call-Back Requests for an ePRO Asthma Symptom Monitoring App Integrated Into Primary Care
Robert Rudin (PI)	Integrating Patient-Reported Outcomes Into Routine Primary Care: Monitoring Asthma Between Visits	Panel: Using Electronic Patient-Reported Outcomes to Monitor Patients Between Visits: Tools and Lessons Across Four Medical Conditions
Robert Rudin (PI), Savanna Plombon	Integrating Patient-Reported Outcomes Into Routine Primary Care: Monitoring Asthma Between Visits	Poster: Towards Equitable Enrollment Into a Clinical Trial of a Digital Health Intervention Using Multi-Pronged Recruitment Strategy

AHRQ-Funded Research Results Noted as Most Relevant, Interesting, or Innovative of the Year

On an annual basis, AMIA identifies the year's most noteworthy publications and showcases them at the AMIA Annual Symposium. This Biomedical and Health Informatics Year in Review is informed by AMIA's 21 Working Groups. These groups identified papers representing the most influential biomedical and health informatics work published over the past year. Of the 92 papers selected, three of the papers presented the results of DHR research: two from the People and Organization Issues Workgroup and one from the Ethical, Legal, and Social Issues Workgroup.

People and Organizational Issues

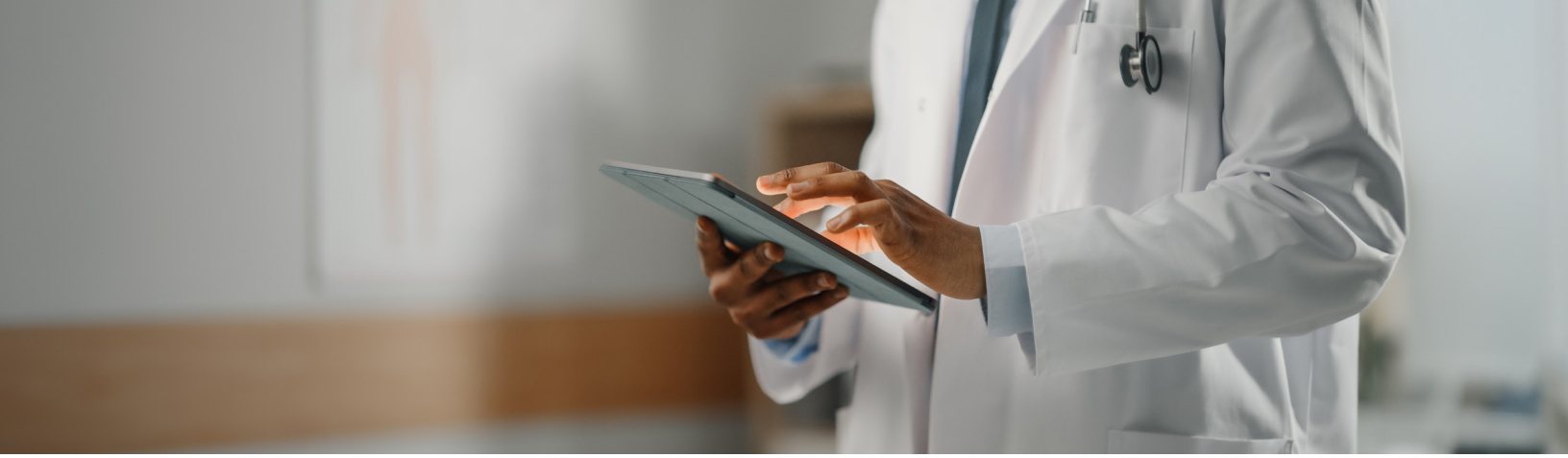
Publications from two DHR-funded grants were highlighted by the People and Organizational Issues workgroup.

Dr. Joanna Abraham's paper in the *Journal of the American Medical Informatics Association*, "Risk factors associated with medication ordering errors," described a study examining instances of medication ordering errors and associated risk factors. The paper describes the team's finding that errors were not uniquely associated with a single risk factor, but the causal contributors of medication ordering errors were multifactorial, arising from a combination of technological-, cognitive-, environmental-, social-, and organizational-level factors.

"Evaluation in Life Cycle of Information Technology (ELICIT) framework: Supporting the innovation life cycle from business case assessment to summative evaluation," co-authored by Dr. Kensaku Kawamoto was published in the *Journal of Biomedical Informatics*. This paper describes an evaluation framework developed by a multidisciplinary team at the University of Utah for supporting the whole lifecycle of EHR-integrated innovations, including the evaluation activities needed at each stage of the cycle: planning, development, implementation, and operation.

Ethical, Legal, and Social Issues

Dr. Rupa Valdez's paper in the *Journal of the American Medical Informatics Association*, "Engaging the disability community in informatics research: rationales and practical steps," was highlighted by the Ethical, Legal, and Social Issues workgroup. Shaped by research and advocacy with the disability comment, this article puts forth a set of guidelines for effective engagement when designing digital health technologies to fully meet the needs of all disabled individuals.



Program Background

About the Digital Healthcare Research Program

The DHR program's mission is to determine how the various components of the ever-evolving digital healthcare ecosystem can best come together to positively affect healthcare delivery and create value for patients and their families.

The DHR Program's vision is that every patient and care team will have ready access to all applicable data and knowledge, supported by advanced analytics and understandable visualizations, to address a patient's health and healthcare. We want the best information to be available to clinicians and patients at the point of care.

AHRQ's digital healthcare initiative is part of the Nation's strategy to put information technology to work in healthcare. By making health information available electronically when and where it is needed, digital healthcare can improve the quality of care, even as it makes healthcare more cost-effective.

To fulfill its mission, the DHR program has invested in research grants and contracts awarded to over 289 distinct institutions in 48 States, the District of Columbia, and Puerto Rico.

What We Fund

In 2022, the DHR program managed:

- 108 grants and 7 research contracts
  - At 69 institutions.
  - In 25 states and the District of Columbia.
  - For a total investment of $172.9 million across all project years.
  - For a total 2022 investment of $29 million, including:
    - $14.3 million in funding from DHR appropriation.
    - $13 million in funding from the Patient-Centered Outcomes Research Trust Fund.
    - $1.7 million in funding from General Health Services Research appropriation

The DHR program's funding opportunities are designed to fund research that fills knowledge gaps and leads to improvements in the design of digital healthcare systems. The program accomplishes this through grant and contract mechanisms that support different types of health services research, including:

- Exploratory and developmental research grants that support research in the early and conceptual stages of development.
- Pilot and feasibility studies.
- Randomized controlled trials and other studies of technology effectiveness.
- Secondary analyses of existing data.
- Scaling and disseminating evidence-based research.
- Supporting conferences that help to further AHRQ's mission to produce evidence to make healthcare safer, higher quality, more accessible, equitable, and affordable.
- AHRQ also invests in the next generation of researchers by funding promising new investigators through awards intended to foster their career development in digital healthcare research.

Learn more about the current AHRQ Digital Healthcare Research funding opportunities here.

Recent priority funding from the DHR program has focused on the following focus areas to add to the evidence base of what and how digital healthcare works best for clinicians, patients and their families, and the healthcare system as a whole:

- Testing how digital healthcare interventions can improve quality of care and healthcare service delivery at the point of care. Learn more.
- How the digital healthcare ecosystem can improve patient safety and how components of it can be safely used and implemented. Learn more.
- Innovative and evidence-based interventions that advance the U.S. goal of achieving equity in the delivery of healthcare services, including reducing disparities in quality of care, patient safety, healthcare utilization and access, and ultimately, health outcomes. Learn more.

Learn More

Want to know more? Visit our website at https://digital.ahrq.gov/ to learn more about our team, current funding priorities, funding opportunities, and the findings and impact of the work we fund.

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