

“This would be so much better if...”

We participate every day in systems that we wish were better. We constantly strive to improve the systems we control and those most integral to our lives and wellbeing. Few would argue that the health care system is both integral to our wellbeing and in desperate need of improvement in quality, efficiency, and patient experience. The desire to improve the health care system has motivated recent shifts in payment reform and efforts to make care more efficient, effective, and patient-centered. These improvement efforts are often underpinned by innovation in health information technology, and can succeed or fail based on how these technologies are designed, implemented, and used. As a result, *those of us designing, implementing, and evaluating these tools must focus our efforts on finding the most effective ways in which health information technology can support systemic improvement of care delivery and human health.*

To that end, my research explores **how the use of information technology can improve health care**. I situate my research at the intersection of health information technology and health policy. The growth of health information technology adoption over the past decade has established the infrastructure and tools to increase information flows between providers, improve clinical decision-making, and ultimately advance the nation’s health. However, to achieve these goals, it is crucial to understand the nature of health information technology use and how policies influence that use, thereby catalyzing or inhibiting system-wide progress. My research aims to illuminate how health information technology use translates to better provider decisions and improved patient and population health. My work informs system implementation and policy at the organizational, state, and federal levels.

My **primary research interest** is in the area of **health information technology use**. I study measures of health information technology use and factors influencing that use. My work focuses on constructing and validating use measures of health information exchange systems and electronic health records with system-generated log data. Furthermore, I study how policies influence the use of health information technology. I examine institutional policies, federal guidelines, and nationwide quality improvement programs that incentivize both providers and hospitals to use health information technology in specific ways. This work informs health information technology use research and regulation of health information technology quality via granular measures of use. It also illustrates the influences and unintended consequences of both state and federal health information technology policy, informing future policy efforts.

Measures of health information technology use. To evaluate health information technology, researchers must study granular and validated measures of system use. In my dissertation work, I use health information exchange log files to construct five novel measures of team-based use of health information exchange in primary care, a critical delivery setting involving team-based care workflows and staggering prevalence of incomplete information. My dissertation work also includes the first study of within-user changes in health information exchange use patterns. Finally, in work funded via an R21/R33 grant from the National Institute on Drug Abuse, I have used electronic health record log data to construct both use and

outcome measures in an evaluation study of clinical decision support tools for opioid prescribing. This work has important implications for both informatics researchers and policymakers seeking to develop guidelines that can be incorporated into health information technology. Published work from this study has appeared in the *Proceedings of the American Medical Informatics Annual Symposium* and future work is targeted to be published in *The Journal of the American Medical Informatics Association (JAMIA)*, among other outlets.

Influence of health information technology policy. A mix of organizational, state, and federal regulations aim to promote health information technology adoption and use, prompting research on the impacts of these policies to inform future regulatory efforts. My research has also examined the influence of state policies regarding patient consent for health information exchange on both provider and hospital exchange use, and has recently been accepted for publication in *The American Journal of Managed Care*. These state policies go hand in hand with federal incentive programs to increase the use of health information technology. The braided relationship between health information technology and delivery system reform has informed my work exploring physician participation in federal incentive programs; this is currently under review at *Health Affairs*. The interrelated nature of health information technology and system reform has also underpinned my research published in *Generating Evidence & Methods to Improve Patient Outcomes (eGEMS)* surveying health information technology literature in the context of accountable care organizations.

My **secondary research interest** is in ***evaluating health system implementation*** of health information technology. I study how clinical decision support systems influence provider behavior and patient health outcomes. Specifically, I have helped design, implement, and evaluate a clinical decision support tool that synthesizes information for providers in their decisions to prescribe opioid pain medications. Additionally, as a part of my T15 predoctoral fellowship in public and population health informatics funded by the National Library of Medicine, I am examining how patient information for the same patient may differ across health information exchange systems. Finally, I have evaluated large-scale health system implementations of electronic health records, specifically investigating system burden as it relates to satisfaction and provider burnout. My work evaluating health information technology implementation informs how health systems can best implement health information technology systems to derive the greatest benefits for both patients and providers. This stream of my research is best suited for publication in *JAMIA* and clinical journals; my system implementation evaluation and burnout manuscript is currently under review with the *Annals of Internal Medicine*.

Finally, I maintain a diverse extended set of research interests that include machine learning and predictive modeling of patient risk using electronic health record data, effective visualization of those risks to inform clinical decision-making, the impact of health information technology regulations on innovation in the sector, and the application of novel data sets for health services and health policy research.

My **future research agenda** extends my primary and secondary areas of research to understand how the use of health information technology impacts patient and population health outcomes. After

establishing validated measures of health information technology use and understanding the policies that most effectively incentivize that use, a natural extension is to explore the extent to which the use of these technologies translates into improved health outcomes for patients. Furthermore, it is critical to focus these studies on specific clinical conditions that stand to gain the most from specific uses of health information technology. For example, patients managing multiple chronic diseases may see considerable improvements in their health outcomes if their providers effectively use health information exchange. The research questions guiding my future work include:

How can health information exchange use be measured for research, policy, and practice?

Do patients whose providers use health information exchange in certain ways have better health outcomes compared to patients whose providers do not?

Do patients at certain stages of disease progression see greater gains in health outcomes from provider use of health information exchange compared to patients in other stages of disease progression?

What conditions have the greatest clinical need for outside information and health information exchange? How do outside information needs differ across conditions?

Do health information exchange systems that tailor information to outside information needs for specific conditions have higher rates of use than those that do not? Do patients whose providers use these need-tailored systems tend to have better health outcomes compared to patients whose providers use other health information exchange systems?

My research agenda as a junior faculty member will focus on the study of how incentives, information system design, and health information technology use can contribute to improved health outcomes. I anticipate that this work will be attractive to **extramural funding agencies** with both policy and clinical areas of focus, as more than half of all Medicare beneficiaries are managing multiple chronic conditions. In particular, the Agency for Healthcare Research and Quality (AHRQ) includes a robust health information technology portfolio, with a focus on improving the quality of care, including health outcomes. Additionally, the National Library of Medicine has long supported innovative research in biomedical informatics, including health information exchange. My work has substantial potential for extramural funding, due to the importance placed on research to advance the use of health information technology to improve patient outcomes.

Furthermore, my research agenda has direct policy **relevance to ongoing legislative and regulatory action**. Following the 21st Century Cures Act, regulators at the Office of the National Coordinator for Health Information Technology (ONC) within the Department of Health and Human Services have been tasked with increasingly complex regulatory responsibilities over interoperability and health information exchange. As a result, these regulators need insight on valid quality measures for health information exchange use and the most appropriate. Additionally, the Centers for Medicare and Medicaid Services have spent almost \$40 billion to fund the incentive programs encouraging adoption of health

information technology, and my work directly contributes to understanding the benefits of that investment. This knowledge is critical to informing future efforts to encourage the most effective use of health information technology.

In conclusion, my research is predicated on the fundamental assumption that ***effective use of health information technology can improve health outcomes***. With my research career, I hope to inform precisely how those improvements can and should take place. Use of health information technology should not be incentivized simply for its own sake. Rather, researchers and policymakers have an obligation to construct policies that encourage and enable the *most highly beneficial* use of health information technology in terms of *patient health outcomes*. Health system leaders and health information technology developers share this obligation. While health information technology certainly has benefits that do not involve direct patient health outcomes, it is my belief that we - researchers, policymakers, health system leaders, and developers - are obligated to do everything in our power to ensure that the investments made in these technologies save lives and improve the health of this nation.

Relevant Research

Harle, CA; Anders, S; **Apathy, NC**; Cook, RL; Danielson, EC; Dilulio, J; Downs, SM; Hurley, RW; Mamlin, BW; Militello, LG. Designing a user-centered electronic health record decision support system for guideline-concordant opioid prescribing. AcademyHealth Annual Research Meeting. June 2018

Apathy, NC; Vest, JR; Adler-Milstein, J; Dixon, BE; Blackburn, J; Harle, CA. Measures of team-based use of health information exchange in primary care. *Under preparation for journal submission.*

Apathy, NC; Vest, JR; Adler-Milstein, J; Dixon, BE; Blackburn, J; Harle, CA. Within-user changes in HIE use patterns over time. *Under preparation for journal submission.*

Apathy, NC; Holmgren, AJ. Opt-in consent policies: potential barriers to hospital health information exchange. *American Journal of Managed Care.* Jan 2020.

Apathy, NC; Vest, JR; Harle, CA. State consent policies and primary care provider usage of health information exchange. *Under preparation for journal submission.*

Apathy, NC; Everson, J. Physician participation across performance categories in the first year of MIPS. *Under Review.*

Balio, CP; **Apathy, NC**; Danek, R. Health information technology and accountable care organizations: synthesis of the literature and future directions. eGEMs (Generating Evidence & Methods to improve patient outcomes). 2019;7(1):24.

Apathy, NC; Harle, CA; Vest, JR; Morea, JG; Menachemi, N. Physician use of electronic health records on days off. *Under Review.*