In this annual report, RCHE presents its research portfolio and emphasizes its processes for conducting research that will have impact upon healthcare delivery. RCHE developed and uses the research-to-impact model to both plan our research and monitor research projects. This is a distinguishing characteristic of RCHE’s approach to healthcare engineering.

This model includes five phases and is presented on page 3. Each of RCHE’s research projects is tracked as it progresses through the five phases. RCHE presents its research in the project matrix table on pages 30–31 and identifies the research-to-impact phase for each research project. Summaries of each individual research project are presented in this report after the project matrix.

RCHE has expanded its research capacity this year and plans continued growth. It has created this capacity by developing four critical resources for a successful healthcare engineering program: faculty, research scientists, partnerships, and Informatics infrastructure. The expansion of informatics infrastructure is summarized on page 4 of this report.

During this past year, Purdue has hired four new faculty who will participate in research with RCHE, two faculty are in the School of Management, and two faculty are in the College of Health and Human Science. Six additional positions are under recruitment and one faculty was awarded a sabbatical for research with RCHE. A newly established academic advisory committee will assist in the recruitment of these faculty and will support them in effective scholarship in their discipline and aligning their research with healthcare engineering.

Last year RCHE announced the expansion of its research scientist program and re-oriented the responsibilities of research scientists to focus on the translation of basic science to healthcare delivery. Three new research scientist positions were opened for recruitment. Two of these positions are filled and an offer to a candidate for the third position is planned before the end of June 2014.

An essential component of RCHE’s approach to healthcare engineering is effective research and dissemination partnerships. RCHE has increased the number and types of partners with whom we are collaborating based on the advice of current partners collaborating in research. The implementation of some of RCHE’s research requires the involvement of sectors of the health delivery system beyond the providers who are current collaborators. The new research and dissemination partners represent these areas of the healthcare delivery system.

RCHE views these developments as very positive and material in our future success. RCHE looks forward to the opportunity to discuss its research and expanded research capacity with you at your June Regenstrief Foundation Board meeting.

Sincerely,

Steve
<table>
<thead>
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<th>Features</th>
<th>Page</th>
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<td>Summary</td>
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Summary

In this report, RCHE is pleased to share forward progress in several key areas: Research-to-Impact model applications, research infrastructure support and development, and research project completions in core research areas.

The center continues to build upon its Research-to-Impact model (page 2–3) in developing research projects and partners. This maintains a focus upon system impact through partner engagement, multi-site validation, and dissemination. Since December, RCHE was able to bring an additional three projects through to the final phase of dissemination. In each of these projects, partner involvement throughout was a critical component of building ownership in the final project and interest in disseminating the results.

Through its work with partners, RCHE has identified research opportunities that require high levels of data processing, analysis, and modeling. After an assessment, the center determined that these needs would only grow, and thus RCHE has committed to developing this infrastructure support to permit these more advanced projects. The addition of an in-house programmer analyst not only increases capabilities but allows the center to work more effectively with primary data as the analyst can participate fully in data processing conversations in advance of receiving the data.

This report also highlights research in two of the center’s research subcategories: transitions and disparities. Gaps in both areas of the healthcare system can significantly affect health outcomes. RCHE brings a breadth of expertise to these areas, with researchers representing disciplines including family studies, communication, engineering, statistics, consumer sciences, and nutrition.

The activities developed and completed during 2013–14 provide important stepping stones for future years. These will assist the center as it continues to pursue projects with advanced requirements in data and transdisciplinary teams.
After pursuing great numbers of projects in its first few years, RCHE, like many other healthcare services research groups, observed how challenging it was to achieve system impact with its research. Reviewing barriers and facilitators led to the creation of the Research-to-Impact model (right), which formalizes the process from academic research to delivery system impact in five phases:

- **A:** Healthcare system evaluation with stakeholder input
- **B:** Research and model development
- **C:** Single-site pilot study and evaluation
- **D:** Multiple-site pilot study and evaluation
- **E:** Dissemination to providers

The model shares many commonalities with translational research but extends this work in two key ways:

1. **Multiple-site pilots:** Because of the variation in healthcare sites, research concepts must be tested in more than one site or situation to ensure validity and generalizability. At this point, any challenges created by variations can become clear and either lead to revisions or be added as controlling factors in the implementation of the final intervention.

2. **Dissemination plan:** A specific dissemination plan and partner involvement throughout the process is helping RCHE research results spread through providers. Involving dissemination partners throughout the process, and not just at phase E, increases engagement and ownership in the end product.

RCHE now applies this approach to all of its center-led projects. Although not all projects will complete the entire process, the Research-to-Impact model brings added structure to project management and keeps system impact at the forefront. The center projects listed on pages 30–31, and described on pages 30–91, each include an indication of their current model phase.
Above, the Research-to-Impact model is shown with an example of a project at each phase. It also indicates the number of center projects at that phase. Left, the projects at each phase are shown. RCHE continues to focus on leading projects through all five phases of the model. Since December 2013, three additional projects have reached the final phase, E.
Building a Research Infrastructure

This year, RCHE invested in developing its information technology infrastructure to support increasingly advanced projects. The addition of a HIPAA-aligned server, a programmer analyst, and additional processing capabilities will assist the center in coordinating data-driven research to support innovation in healthcare.

Protecting and Processing Data

Many center research projects involve sensitive healthcare data. This year, RCHE finished establishing two HIPAA-aligned server environments. The first supports more traditional campus-based research and analysis. The second provides expanded capacity for improving collaborations, research dissemination, and impact. By making the CatalyzeCare server HIPAA-aligned, the center is taking the first step toward creating a secure online environment for research collaborations with protected health information. In the future, RCHE envisions that researchers and providers from around the country will be able to meet online for research collaborations, to examine results, and to learn from completed studies and tools on the hub. This added security will further enable CatalyzeCare to serve as a research dissemination and impact vehicle to support improved healthcare delivery.

A gap analysis with center researchers identified the need for a staff member with advanced data and programming skills. Programmer Analyst Kit Klutzke joined the center this spring, bringing data processing and de-identification capabilities in house. The added capacity supports the center’s research scientists and faculty in their pursuit of data-driven impact projects.

Evaluating Tools

RCHE’s IT strategy moves forward through constant needs analysis and evaluation. The center has committed significant resources to developing CatalyzeCare and is also continually assessing its value as a knowledge and community development tool. The center’s first such project, Infusion Pump Informatics, continues to expand with new members and is being recognized by external groups as a successful tool and community. This year, the resource was added to the Healthcare Technology Safety Institute Infusion Device Steering Committee. Additionally, the Association for Advanced Medical Instrumentation has expressed interest in working with the center and CatalyzeCare to develop another knowledge community within the hub. The addition of another such community with different members will provide important comparison and validation opportunities for the CatalyzeCare hub.
Transitions in care represent very important but challenging points in the healthcare system; however, they are also excellent examples of areas in which systems engineering can provide a different perspective. RCHE’s research in Critical Access Hospital readmissions targets points of care transitions but in a healthcare setting with important differences from the current, more common body of readmissions research.

Critical Access Hospitals

A patient’s discharge from the hospital represents a transition in their care largely due to a change in their care team and location in which they convalesce. During this transition period they are at risk for discontinuity of care which has been associated with increased probability for negative impact on the patients’ health status and care costs. A growing body of research is studying transition post discharge from hospitals receiving capitated reimbursement through the prospective payment system (PPS). There are limited studies pertaining to patient transitions following discharge from critical access hospital (CAH — rural hospitals with less than 25 beds).

The prevailing assumption is that CAHs should use the same patient transition management techniques that are being developed for PPS hospitals. This study collected four years of patient experience in five critical access hospitals in Indiana. The types of patient transitions were identified and then compared to CAH and PPS hospitals in Arkansas and Washington to assess the degree to which the Indiana experience represented CAHs in other areas. The CAH experience was then compared to the PPS hospital to assess the validity of this assumption.

The findings indicate that CAHs have more complicated post-discharge patient transitions than is common in PPS hospitals and thus would benefit from customized processes to manage their patients’ care. Complications in post-discharge care emanate from the following types of transition issues which are more prevalent in rural areas.

- A limited number of primary care providers in most rural communities to provide longitudinal continuity of care as evidenced by greater numbers of index admissions and readmissions for ambulatory care sensitive conditions, and increased non-emergent use of the CAH emergency department.

- Between 25 and 50 percent of all patients who present to a CAH and require inpatient care are transferred to a PPS hospital providing a greater scope of care. Most rural communities do not have established processes to provide care continuity when transferred patients return to their community. A higher
number of transferred patients have urgent emergency department within 30 days of their transfer than was observed in PPS hospitals.

- The types of patient conditions treated in CAHs vary on a hospital-by-hospital basis. As CAHs develop improved techniques for management of patient transitions there will be a need to have techniques which are tailored to their individual needs and fit within prevailing community resources.

This study has been presented at the Indiana Rural Hospital Association annual meeting and the national conference of the Association for Community Health Improvement. A draft article is being completed for submission to the *Journal for Rural Health*. RCHE has begun the next stage of this research, which focuses upon Rural Community Healthcare Utilization: Changes Resulting From Improved Access to Primary Care and upon the use of information innovations to improve the timeliness and communication of clinical information pertaining to patient care transitions.

This graph (left) shows the differences in total admissions and readmissions from ambulatory-care sensitive conditions in the study’s critical access hospitals (CAH) and prospective payment system hospitals (PPS). ACSCs are often considered potentially preventable readmissions because they can usually be handled in a primary care practice if caught soon enough. This suggests that there are opportunities to reduce readmissions through transitions management in Critical Access Hospitals.
RCHE conducts research on several types of disparities that have been demonstrated to reduce optimal healthcare delivery: ethnic, cultural, educational, socio-economic, and geographic.

**CUAHD**

As originally reported in December 2013, Communications professors Mohan Dutta and Bart Collins received a $1.5 million AHRQ grant to study culturally centered approaches to increasing awareness. They developed a highly collaborative and community-driven project, co-led by volunteer teams in each of their two experimental communities of Lake and Marion Counties. The teams' goal was to increase community members' awareness of evidence-based resources for heart health care available at AHRQ.gov. Heart disease is a significant health threat for African Americans but pre-study surveys showed that many in the communities were unaware of the types of treatments available. However, they hypothesized that previous campaign had not worked because they were developed by those outside of the community and its culture. He suspected that campaigns that were targeted by the community and for the community would be more successful.

Community knowledge was tested through a 33-item true/false test with content from four subject areas: ACE-I/ARBs, cholesterol, atrial fibrillation, and renal artery stenosis (RAS). Results indicated that in three of the four subject areas (cholesterol being the exception), the campaign communities displayed an increase in knowledge over the control community (Figure A, below). Overall knowledge was also notably increased in the campaign communities (Figure B, below).

A manuscript is being developed for publication. The team’s strategy will also be available on the AHRQ website for other communities to use.

![Figure A. Knowledge in each of four subject areas, post-intervention.](image)

![Figure B. Overall knowledge post-intervention.](image)
COPHI

The Center on Poverty and Health Inequities (COPHI) is an RCHE sub-center established to lead healthcare disparities research. Faculty from several colleges meet regularly to discuss projects, develop research concepts, and network about resources. Illustrating the overlap evident in many disparities projects, most members of COPHI are active in other center projects and research areas.

COPHI faculty are currently involved in projects dealing with access to care in rural areas, food security and food deserts, socio-economic and geographic disparities, and cultural competency in physician-patient communication.

This year, two new senior faculty members joined Purdue and COPHI — Elliot Friedman, PhD, and Stewart Alexander, PhD. Both bring to the group their experience leading large funded research projects. Friedman’s research focuses on the biopsychosocial processes — health-related biological processes and the ways in which they are patterned by social factors, psychological functioning, and behavior. Alexander is a communications methodologist interested in physician-patient communication.

Cleveland Shields, PhD, is the director of the Center on Poverty and Health Inequities. Shields is currently leading an NIH-funded project to examine how Black men receive treatment for pain based on a variety of physician-patient communication and engagement factors.
### Core and Extramural Funding

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Leverage factor, grant period 1 (2008–2013): 3.63
Leverage factor, grant period 2 (2013–2018): 1.1
External Funding: Grant Highlight

**MCTP: Sophomore Transitions: Bridges into a Statistics Major and Big Data Research Experience via Learning Communities**

PI: Mark Daniel Ward, Associate Professor of Statistics

$1,500,000

September 1, 2013–August 31, 2018

Funded by the National Science Foundation.

This program builds upon a successful summer collaboration between RCHE and Purdue's Actuarial Science program. In collaboration with the program, RCHE will provide opportunities for selected students to conduct research upon healthcare datasets that are not insurance-related. This gives the students an understanding of other real-world applications for their skills, and provides RCHE with different perspectives on its data.
Appendix A:
Research Areas
Care Coordination: Safety

RCHE’s work in Safety researches infrastructure and innovation mechanisms that support partners in improving patient safety. Projects in this area include IV medication administration safety research covering team dynamics and alert fatigue, and post-op care to reduce patient falls and accidents.

Researchers

James Anderson, PhD — Sociology, Purdue University
Elisa Bertino, PhD — Computer Science, Purdue University
Ann Christine Catlin — Rosen Center for Advanced Computing, Purdue University
Karen Chang, PhD — Nursing, Purdue University
Susan DeCrane, PhD — Nursing, Purdue University
Dan Degnan, PharmD — Pharmacy, Purdue University
Ben Dunford, PhD — Management, Purdue University
Steve Landry, PhD — Industrial Engineering, Purdue University
Ken Musselman, PhD — Regenstrief Center for Healthcare Engineering, Purdue University
Luo Si, PhD — Computer Science, Purdue University
Steve Witz, PhD, MPH — Regenstrief Center for Healthcare Engineering, Purdue University

Healthcare Partners

Aurora Health Care
Cameron Memorial Community Hospital
Community Health Network
Deaconess Health System
Indiana University Health
Indianapolis VAMC
Nebraska Medical Center
St. Vincent Health
St. Francis Hospital
University of Iowa Hospitals and Clinics
University of Nebraska
University of Wisconsin Hospitals and Clinics
Wishard Hospital
Recent Publications


Care Coordination: Patient Centeredness

The Patient Centeredness research category encompasses projects designed to improve understanding, measurement, and interventions that contribute to patient centeredness. Research in this area covers topics such as health literacy, patient engagement, physician-patient communication, and family involvement.

Researchers

Bart Collins, PhD — Brian Lamb School of Communication, Purdue University
Ken Ferraro, PhD — Sociology, Purdue University
Melissa Franks, PhD — Human Development & Family Studies, Purdue University
Kim Plake, PhD — Pharmacy Practice, Purdue University
Cleveland Shields, PhD — Human Development & Family Studies, Purdue University
Maria Venetis, PhD — Brian Lamb School of Communication, Purdue University
Karen Yehle, PhD — Nursing, Purdue University

Healthcare Partners

St. Vincent Health System
Wishard Health Services

Recent Publications


Care Coordination: Patient Centeredness


Care Coordination: Care Transition

RCHE’s Care Transitions research addresses issues in transitions of care that affect care coordination. Projects in this area include potentially preventable readmissions, team dynamics, and organizational mechanisms to support coordination.

Researchers

Peter Baker, — Purdue University
Bruce Craig, PhD — Statistics, Purdue University
Laila Cure, PhD — Western Michigan University
Peter Fabri, MD, PhD — University of South Florida
Ping Huang, PhD — Regenstrief Center for Healthcare Engineering
Sara McComb, PhD — Nursing, Purdue University
Ken Musselman, PhD — Purdue University
Joseph Thomas, PhD — Pharmacy Practice, Purdue University
Laura Sands, PhD — Nursing, Purdue University
Zhiyi Tian — Purdue University
Karen Yehle, PhD — Nursing, Purdue University
Benjavan Upatising, PhD — Purdue University
Hong Wan, PhD — Purdue University
Brandon Pope, Baylor Medical Center
Steve Witz, PhD — Health Sciences and Regenstrief Center for Healthcare Engineering
Jia Xu, PhD — Purdue University
Jose Zayas-Castro, PhD — University of South Florida
Michael Zentner, PhD — Purdue University
Lingsong Zhang, PhD — Purdue University

Healthcare Partners

BayCare Health System
Cleveland Clinic
Michiana Health Information Network
St. Vincent Health

Recent Publications

Research Areas

Care Coordination:
Care Transition


Research Areas

Population Health: Utilization

Utilization research explores how patients use healthcare services, why, and how that use can be managed to deliver better healthcare and achieve improved outcomes. Projects in this area cover clinical scheduling, utilization modeling and analysis, the population health model, and accountable care organization support.

Researchers

Ping Huang, PhD — Regenstrief Center for Healthcare Engineering
Mark Lawley, PhD — Biomedical Engineering, Purdue University
Nan Kong, PhD — Biomedical Engineering, Purdue University
Sara McComb, PhD — Nursing, Purdue University
Laura Sands, PhD — Nursing, Purdue University
Joseph Thomas, PhD — Pharmacy Practice, Purdue University
Zhiyi Tian — Regenstrief Center for Healthcare Engineering
Steve Witz, PhD — Health Sciences and Regenstrief Center for Healthcare Engineering
Lingsong Zhang, PhD — Purdue University

Healthcare Partners

Alliance of Chicago Community Health Service
Indiana State Department of Health
Rehabilitation Hospital of Indiana

Recent Publications


Population Health: Disparities

RCHE’s Disparities research includes its sub-center, the Center on Poverty and Health Inequities (COPHI). Projects address issues in access, affordability, cultural competency, and education in populations experiencing health disparities.

Researchers

Lalatendu Acharya, PhD, MBA — Consumer Sciences and Retailing, Purdue University
Ayše Ciftçi, PhD — Educational Studies, Purdue University
Mohan Dutta, PhD — Brian Lamb School of Communication, Purdue University
Heather Eicher-Miller, PhD — Nutrition Sciences, Purdue University
Elliot Friedman, PhD — Human Development & Family Studies, Purdue University
Haslyn Hunte, PhD — Social and Behavioral Sciences, West Virginia University
Blake Jones, PhD — Human Development & Family Studies, Purdue University
Meghan Norris, PhD — Consumer Sciences and Retailing, Purdue University
Sara Schmidt, PhD — Human Development & Family Studies, Purdue University
Cleveland Shields, PhD — Human Development & Family Studies, Purdue University
Frank Snyder, PhD, MPH — Health and Kinesiology, Purdue University
Maria Venetis, PhD — Brian Lamb School of Communication, Purdue University

Healthcare Partners

Indiana Minority Health Coalition

Recent Publications


Research Areas

Population Health: Disparities

Emerging Research Interests

Emerging Research Interests describes developing research areas that appear promising for advancing their respective fields and having impact on healthcare delivery. Projects in this area include surgical support robotics, EMS optimization, and assistive technologies.

Researchers

Masha Shunko, PhD — Management, Purdue University
Juan Wachs, PhD — Industrial Engineering, Purdue University

Healthcare Partners

Marion County EMS
IU School of Medicine

Recent Publications


Jacob, M. G., & Wachs, J. P. (2014). Context-based hand gesture recognition for the operating room. Pattern Recognition Letters, 36(0), 196-203. doi: http://dx.doi.org/10.1016/j.patrec.2013.05.024


Appendix B: Project Summaries
About the Summaries

The project summaries in this section provide an overview of key aspects of each project with which RCHE is currently involved. The guide below indicates key features of the table on the next two pages:

**A:** Project Title.

**A1:** Projects are sorted into one of three areas: Emerging Research Interests, Care Coordination, or Population Health.

**B:** Project subcategories reflect those discussed at the start of the previous section (descriptions on page 25).

- Care Coordination
  - Safety
  - Patient Centeredness
  - Care Transitions
- Population Health
  - Utilization
  - Disparities

**C:** Research-to-Impact phase in which the project is currently operating.

### Care Coordination

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<tr>
<th>Project Title</th>
<th>Page</th>
<th>Sub Category</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
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### Research-to-Impact Phases

**A:** Healthcare system evaluation with stakeholder input

**B:** Research and model development

**C:** Single-site pilot study and evaluation

**D:** Multiple-site pilot study and evaluation

**E:** Dissemination and evaluation
# Project Matrix

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<thead>
<tr>
<th>Project Title</th>
<th>Page</th>
<th>Sub Category</th>
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<th>B</th>
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### Project Matrix

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**Emerging Research Interests**

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**Total**

1 12 8 4 4

* Indicates a new project since the last report.

X→X Indicates projects that have moved since the last report. X marks the previous phase and X marks the current phase.
Alert Threshold Guidance: Reducing IV Smart Pump Fatigue

Research Team

Faculty
- Steven J. Landry, Industrial Engineering

Student(s)
- Hyo-sang Yoo, Industrial Engineering
- Harsh Aggarwal, Industrial Engineering
- Nsikak Udo-Imeh, Industrial Engineering
- Adithya Raghavan, Industrial Engineering

Healthcare Partner
- Wishard
- UW Health
- St. Francis Hospital
- Community Health Network
- University of Nebraska
- University of Iowa

Research Direction

Research Focus Area
- Care Coordination

Competencies
- Human factors
- State-based modeling

Research-to-Impact Phase
- Phase B (research and model development)

Research Timeline
- 6/2011–6/20135

Project Summary

Healthcare Problem
When infusion pumps generate too many alerts, healthcare providers can experience alert fatigue. This may lead to alerts being overridden more often or not taken seriously, and alerts being ignored, all of which can impact patient safety. More accurate setting of high and low limits can reduce alerts so that they are still useful but not obtrusive.

Research Objectives
1. To improve the care of patients using infusion pump systems; and
2. To reduce the workload of healthcare providers in responding to alerts from infusion pump systems.

Methodology
This research will identify optimal alerting thresholds for infusion pump systems based on data collected by IPI; report on and apply
human factors principles for alerting systems design for infusion pump systems; and develop an alternate or supplemental method for alerting based on a recently developed framework for alerting system design in aviation.

**Potential Impact**
Reducing alert fatigue by reducing the number of alerts can significantly impact patient safety. Fewer “nuisance” alerts mean that the alerts that are generated are more likely to be taken seriously. This can also help improve compliance (use of the pump within the safety guards), which also contributes to better patient safety.

**Project Update**
The research team has developed a decision support tool for adjusting guardrail limits. Using the IPI data, the tool shows hospitals what the reprogram and override rates would be for different guardrail limits for a selected drug. The tool will allow pharmacists to view how overall behaviors may change given different limits. The team is hoping to test the tool with several IPI participating hospitals during the first half of 2014.
Project Summaries

Supporting a Community of Practice to Improve IV Medication Safety

Research Team

*Faculty*  
Rich Zink, Regenstrief Center for Healthcare Engineering

*Students*  
Hyo-sang Yoo, Industrial Engineering  
Harsh Aggarwal, Industrial Engineering  
Nsikak Udo-Imeh, Industrial Engineering  
Adithya Raghavan, Industrial Engineering

*Healthcare Partner*  
Aurora Health  
Cameron Memorial Community Hospital  
Community Health Network  
Deaconess Hospital  
Eskenazi Health  
Franciscan St. Francis Health  
Good Samaritan Hospital Vincennes  
IU Health  
Indianapolis Roudebush VAMC  
St. Mary’s Hospital  
University of Iowa Health Care  
University of Nebraska Hospital  
University of Wisconsin Hospital

Research Direction

*Research Focus Area*  
Care Coordination

*Competencies*  
Community building

*Research-to-Impact Phase*  
Phase D (Multiple-site pilot and evaluation)

*Research Timeline*  
2012–ongoing

Project Summary

*Healthcare Problem*  
Infusion pumps are one of the most widely used technologies in healthcare today. But infusion errors and pump failures can and have caused serious harm, and even death, to patients. Over a five-year period, more than 56,000 adverse events and 710 deaths associated with infusion devices were reported to FDA—more than for any other medical technology.
Project Summaries

Research Objectives
Improve safety, efficacy, and efficiency when using infusion pumps. This includes improving patient safety, reducing alert fatigue, improving drug library management, etc.

Methodology
The scientific collaboration platform, www.CatalyzeCare.org, is leveraged as the collaboration space for providers and researchers. Providers share information within the community via document repositories, containing drug libraries and other documents, and threaded discussions allowing clinicians to get information and answers from their peers.

RCHE provides the collaboration space, supports the community by hosting regular community meetings, and provides technical support for using CatalyzeCare.

Potential Impact
Supporting this community of practice provides a dissemination vehicle for RCHE research. Additionally, communities of practice are being developed nationwide as a method of addressing the need for research dissemination. RCHE’s support of and research into communities of practice can assist others in establishing successful communities.

Project Update
An IPI conference was held on May 21-22 in Indianapolis. The agenda includes a tour of Eskenazi Health, a networking dinner and presentation, a keynote presentation by Karl Gumpper (Boston Children’s Hospital) and Bona Benjamin (American Society of Health-System Pharmacists), a research report on Team Dynamics, a Development update, a presentation on communicating with the C-suite, and three breakout sessions (1. Clinical Advisories; 2. Pharmacy-Nursing Communication; and 3. Use Case / Case Study).

During this period Good Samaritan Hospital Vincennes and the Parkview Health System (Indiana) were added to the community.

RCHE participation in this community resulted in an invitation to join the Healthcare Technology Safety Institute (HTSI) Infusion Device Steering committee. The IPI system and community was demonstrated during a conference call on January 22, 2014. The next HTSI Infusion Device Steering committee meeting is scheduled for June 2 in Philadelphia.
Project Summaries

Nursing Attitudes and Perceived Causes of IV Pump Workarounds

Research Team

*Faculty*  
Ben Dunford, Management

*Healthcare Partner*  
University of Iowa Health Care  
Wishard Health  
University of Wisconsin Hospitals and Clinics

Research Direction

*Research Focus Area*  
Care Coordination

*Competencies*  
Team dynamics

*Research-to-Impact Phase*  
Phase E (dissemination and evaluation)

*Research Timeline*  
2012–15

Project Summary

*Healthcare Problem*  
While workarounds are a common part of any work environment, they can signal larger process issues that need to be addressed. In the case of IV pumps, nurses are on the front lines of using the pumps but are rarely involved in the process of developing or installing the pumps. Smart IV pumps should provide additional patient safety benefits; however, if nurses are having difficulties and need to use workarounds, these benefits may not be being realized.

This project seeks to understand attitudes and perceived causes of workarounds with smart IV pumps. As an earlier stage research project, the researcher is also seeking to develop and evaluate potential new research questions.

*Research Objectives*  
1. Establish a list of potential causes of workarounds.  
2. Examine potential methods of perpetuating workarounds through the workplace.

*Methodology*  
An anonymous online survey was conducted. Sample size is approximately 800 nurses across all three institutions. The survey used a variety of question formats, including open-ended, dichotomous, and Likert scale.
**Potential Impact**

If workaround causes can be identified, changes may be able to be made to avoid the need for disruptive workarounds, potentially increasingly the likelihood that nurses would use the pumps and their safety features more.

**Project Update**

Paper conditionally accepted for publication in the *Journal of Patient Safety*. The team is looking to write 2 more papers.

Results: 818 nurses were surveyed across three hospital systems using a short, online, anonymous survey instrument.

Training and troubleshooting: Approximately 86% of those surveyed learned how to use the pumps through on-the-job training. More than nine out of ten (92%) sought out colleagues for help when problems arose with the pumps.

Workarounds: Leading causes were identified as technology related (44%) and organization related (47%). Examples of workarounds used were:

- Basic infusions instead of using guardrail programming;
- Programming extra volume to account for extra fluid;
- Increasing rate rather than using a Bolus dose;
- Using a concentration not in the library.
Project Summaries

Development of the Infusion Pump Informatics System

Research Team

Faculty
Ann Christine Catlin, ITaP/Rosen Center for Advanced Computing

Students
Sudheera Fernando
Sumudinie Fernando
Ruchith Fernando
Ruwan Gamage

Healthcare Partner
Aurora Health
Cameron Memorial Community Hospital
Community Health Network
Deaconess Hospital
Eskenazi Health
Franciscan St. Francis Health
Good Samaritan Hospital Vincennes
IU Health
Indianapolis Roudebush VAMC
St. Mary’s Hospital
University of Iowa Health Care
University of Nebraska Hospital
University of Wisconsin Hospital

Research Direction

Research Focus Area
Care Coordination

Competencies
Data visualization
Databases

Research-to-Impact Phase
Phase E (dissemination)

Research Timeline
4/1/2013–3/30/2014

Project Summary

Healthcare Problem
The alert data collected by infusion pumps can be used to create improvements in patient safety; however, the data must be in a format that is reliable, timely, and user-friendly. The collection capabilities that accompany infusion pumps often provide limited data analysis capabilities, which may not be interactive enough to answer more detailed questions.
**Research Objectives**

The objectives of this segment include:

1. To integrate Hospira processing and data into the database;
2. Develop hub solutions to support the future growth of the system;
3. Develop and launch Compliance tracking;
4. Create new charts including “time to override”;
5. Support limited drug comparisons across hospitals; and
6. GUI and data selection upgrades to meet community needs.

**Potential Impact**

The analysis enabled through this project helps hospitals identify areas for improvement and education in their IV medication administration process. The community of practice that is growing through this project provides professional networking and support for healthcare providers focused on this issue, and helps them disseminate important results to their colleagues for even greater improvement.

**Project Update**

The IPI development team has been developing new features, refining and upgrading existing features, and maintaining the database and data integrity to remain up-to-date with manufacturer changes. Recent feature additions both support the community’s use of the data for immediate impact on patient safety as well as supporting center research looking at broader issues.

Smart pump compliance data identifies the percentage of infusions delivered to patients that are within the control of the limit library. This is a critical number for medication safety, since unless the limit library is operating, alerts will not be generated and data will not be captured. The implementation of IPI support for compliance required investigation of the data captured by the pump for “counting” the number of total infusions, the number of in-library infusions and the number of basic infusions. Compliance data is now uploaded regularly by all hospitals and the charts interface is user-friendly and comprehensive for single hospital study and cross hospital comparison.

Time-to-override is defined as difference (in seconds) between the timestamp of a field limit alert and the timestamp of the first override action to that alert by the nurse. A collection of Time-to-Override charts was added to IPI for the study of alert fatigue.
Charts in this series include the monthly trend for alerts with two seconds or less override time, a frequency distribution graph showing the number of alerts with specific override times in seconds (from 1 to 20), and a ratio chart showing the percent of total override alerts contributed by alerts with specific override times in seconds.

Hospira smart pump alert data and analytics support is now fully integrated into the IPI database and graphical interface. IPI now fully supports both Carefusion and Hospira pumps.

Field limit types breakout for parameterization of analysis charts and investigative reports is the most important data search feature added to IPI this year. This is a system-wide parameter that users can select to filter on all charts and reports, in order to investigate a specific infusion programming type. Manufacturers vary widely in the values for this parameter, and in fact Hospira infusion programming data even presents different field limit types for different devices. This new feature is critically important, as it allows IPI to support Hospira hospitals separation of device type data on charts and reports.
Improving Medication Adherence through Practitioner and Patient Health Literacy Education

Research Team

Faculty  Kim Plake, Pharmacy
Healthcare Partner  Wishard Health Services

Research Direction

Research Focus Area  Care Coordination
Competencies  Health literacy assessment
  Health literacy intervention
Research-to-Impact Phase  Phase C (single site pilot)
Research Timeline  June 2011–December 2013

Project Summary

Healthcare Problem  Treatment adherence after cardiovascular events has been cited as being as low as 54 percent after one year. Functional health literacy has been shown in a number of studies to affect a patient’s medication adherence. Prior to an Institute of Medicine report in 2004, little health literacy education was provided in professional schools, leaving many nurses and pharmacists ill-equipped to work with low health literacy populations.

Research Objectives  This project seeks to develop and implement a health literacy education program to assist providers in working with patients of varying levels of health literacy. The program will also enable clinicians to develop their own patient education approaches and tools. Long term, the program objectives are to:
  1. Integrate health literacy tools into contemporary practice;
  2. Improve adherence to antihypertensives and cholesterol-lowering medications; and
  3. Improve clinical outcomes in patients with low health literacy.

Methodology  A comprehensive list of gaps and unmet needs was established through a review of the literature and in consultation with various practitioners. An in-person session will be developed with material to address these gaps. A website will also be developed to serve as an additional resource after the presentations.
The program will be assessed using a decision-oriented logic model type developed by the Kellogg Foundation and recommended for complex program designs.

**Potential Impact**

Patients who are more health literate are more able to understand their condition, participate in managing it, and adhere to their treatment regimen, thereby improving their health.

**Project Update**

This project was jointly funded by the Regenstrief Center for Healthcare Engineering and Pfizer. It builds on the faculty members’ existing expertise in patient health literacy and health literacy education developed through several previous projects. RCHE provided seed funding for one such project and others have been externally funded.

The RCHE funds were used primarily to purchase an automated refill reminder system. The refill reminder system calls patients to remind them to get their prescriptions refilled. It is automated and allows the patient to choose to refill the prescription when on the call.

Data collection has concluded and the team is currently conducting its analysis. The data collected included medication adherence (proportion of days covered) and the providers’ educational outcomes. Analysis results will be presented in the next report.
Project Summaries

Improving Primary Care Delivery Through Patient-Centered Allocation of Resources

Research Team

Faculty
- W. Bart Collins, Communications
- Brandon Pope, Industrial Engineering
- Cleveland Shields, Human Development & Family Sciences
- Steve Witz, Regenstrief Center for Healthcare Engineering
- Lingsong Zhang, Statistics
- Mike Zentner, ITaP

Students
- Ravi Rajesvaran, Statistics and Mathematics

Healthcare Partner
- Amy LaHood, MD, MPH, FAAFP
- Curt Ward, MD, MBA, FAAFP, Program Director, St. Vincent Family Medicine Residency Program
- Maurice Magdi Henein, MD, Clinical Faculty at St. Vincent Family Medicine
- Josh McKinnon, MD, St. Vincent Health

Research Direction

Research Focus Area
- Care Coordination

Competencies
- Patient Centeredness
- Model development

Research-to-Impact Phase
- Phase C (single site pilot)

Research Timeline
- 7/12 – 6/14

Project Summary

Healthcare Problem
The delivery of high quality patient-centered care (PCC) is essential for improving the health of Americans and for containing the costs of medical care. The quality of PCC delivered in a healthcare system is difficult to measure, which limits the healthcare system’s ability to provide and improve their delivery of PCC. A critical barrier to providing patient-centered care is the potential disconnect between patients’ evidence-based needs and personal preferences. This study seeks to improve healthcare by improving the measurement of PCC, and understanding its enablers and benefits.
**Research Objectives**

1. To identify gaps in patient and physician perceptions of needs, wants, and the primary care that is delivered; and
2. To identify the sources and consequences of these gaps.

**Methodology**

Retrospective chart reviews will help identify relevant health outcomes of the patients in the cohort. This data on health outcomes will serve as initial evidence of the relationship between various measures of patient-centeredness and health outcomes.

**Potential Impact**

This project will contribute to measurement methods for patient centeredness by developing a method that accounts for multiple dimensions as well as resource restrictions. It will impact patients when the findings are disseminating in resident training programs to help resident physicians learn about meeting and managing patient perceptions and expectations.

**Project Update**

Last fall the research team completed an initial survey of St. Vincent family medicine clinic patients to examine multiple measures of patient-centered care (PCC), including a new measure of patient-centeredness developed by the research team. This survey provided initial data regarding the relationships of different measures of PCC to self-reported patient outcomes. In January 2014, the resident completed six-month retrospective chart review protocol examining clinical changes, medication adherence, and office visit adherence for patients originally surveyed in the initial protocol. Initial findings suggest that different measures of PCC are likely associated with different types of health and behavioral outcomes.

Following these results, the team has received IRB approval for a second, larger patient survey and subsequent chart review protocol to be conducted on a broader range of patient from both the St. Vincent family medicine and the internal medicine residency programs. This study is a follow-up to allow further refinement of the new measure of PCC, replicate prior results, and examine the relationship between patient-centered care and patient activation. Within the next six months the team anticipates completion of the second patient survey, which will also identify the patient population for the follow-up chart review protocol. Potential publication outlets for the first study are being identified and manuscript preparation is underway. The researchers anticipate submitting the initial study results to the *Journal of Family Medicine*. 
Project Summaries

Hospital 30-Day Non-Index Readmission Risk Measure and Analysis

Research Team

Faculty
Ping Huang, Regenstrief Center for Healthcare Engineering
Steve Witz, Health Sciences and Regenstrief Center for Healthcare Engineering

Students
Wei Liu, Industrial Engineering

Research Direction

Research Focus Area
Care Coordination

Competencies
Statistical analysis

Research-to-Impact Phase
Phase D (multiple-site pilot study and evaluation)

Research Timeline
1/2013–05/2014

Project Summary

Healthcare Problem
Hospital 30-day readmission is widely recognized as a marker of care quality as well as a significant factor of the rising healthcare costs. Therefore, how to reduce hospital 30-day readmission has gained increasing interests nationwide for the purpose of both reducing cost and improving quality.

The hospital readmission defined by CMS includes readmission to the same hospital as well as readmission to a different hospital. For patients who are readmitted to a hospital other than the ones that provided their previous hospitalizations, it is likely that they will receive care from a different group of providers. Potential issues in communication between hospitals and lack of sharing patient medical records may become the barriers of the continuity of care, which may lead to patients not getting the needed care, receiving duplicated care, or suffering from medical errors. Current studies primarily focus on analyzing general cases of hospital readmissions without considering the variation in readmitting hospitals.

Research Objectives
The objective of this research is to investigate the association between two types of patient group classified by readmission types and their related hospital utilizations as well as identify potential factors that may help to predict high hospital utilization patients.
**Methodology**

Several hospital utilization indicators are compared between two types of patient group classified by the type of readmission that they experienced. In addition, several patient characteristics are examined to identify high hospital utilization patients using logistic regression. Furthermore, a Poisson regression model is developed to examine the association between patient group types and hospital readmission rate controlled by patient characteristics.

**Potential Impact**

Providing an analysis of patient characteristics of those who tend to return to index versus non-index hospitals can provide hospitals with a place to start to both identify patients who might return and begin to develop strategies to promote better health outcomes.

**Project Update**

This project focuses on index versus non-index readmissions. Non-index and index hospital readmissions are identified based on whether the readmission occurred in a hospital that was different from the one in which a patient had his/her previous hospitalization.

Preliminary results:

- 77% of the hospital readmissions are index hospital readmissions. 23% are non-index hospital readmissions.
- In Arkansas, 28% of patients had non-index readmissions while 72% of patients had index hospital readmissions.
- Patients in the non-index readmission group tend to have significantly higher inpatient utilizations than patients in the index readmission group, as measured by (i) the total hospital admissions per year per patient, (ii) total hospital readmissions per year per patient, (iii) total emergency room visits per year per patient, (iv) total hospital days per year per patient, and (v) the average number of hospitals with which a patient has interacted.
- Multiple factors are identified as effective contributors that differentiate index and non-index readmission patient groups. They include the patient’s (i) health insurance, (ii) location, and (iii) number of comorbid conditions. Patients in the non-index readmission group are more likely to be covered under Medicare, to live in rural or isolated area, and to have hypertension, a blood disorder, or a substance abuse/mental disorder than patients in index readmission group.
Hospital Readmissions

Research Team

Faculty
- Hong Wan, Purdue University
- Brandon Pope, Baylor Medical Center
- Lingsong Zhang, Purdue University
- Jia Xu, Purdue University
- Maribeth Slebodnik, Purdue University
- Jose Zayas-Castro, University of South Florida
- Peter Fabri, University of South Florida
- Laila Cure, Western Michigan University

Staff
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- Michael Zentner, Purdue University
- Peter Baker, Purdue University
- Zhiyi Tian, Purdue University

Students
- Cody Mullen, Purdue University
- Kalada Kienka, Purdue University
- Florentino Rico Fontalvo, University of South Florida
- Diego Martinez, University of South Florida
- Yazhuo Liu, University of South Florida
- Ching-Wei Cheng, Purdue University

Healthcare Partner
- BayCare Health System

Research Direction

Research Focus Area
- Care Coordination

Competencies
- Data analysis
- Modeling
- Statistical analysis

Research-to-Impact Phase
- Phase D (multi-site pilot and evaluation)

Research Timeline
- I: April 2010 - May 2011
- II: June 2011 - June 2012
- III: July 2012 - August 2012
- IV: August 2012 - June 2013
- V: July 2013 - June 2015
Project Summary

Healthcare Problem

Existing studies of hospital readmissions typically focus on specific diagnoses, age groups, discharge dispositions, payers, or hospitals, and often use small samples. It is not clear how predictive models generated from such studies generalize across diseases, hospitals, or time frames. The goal of this project is to construct a generic model of readmission risk which can be applied to the majority of inpatient admissions, and validate the model's ability to extrapolate across hospital sites and time frames. To better convey the nature of the model, a computer application will be built for demonstration purposes.

Research Objectives

1. Refine BayCare’s readmissions risk statistical models based on latest research findings.
2. Embellish the Readmission App code to be better aligned internally.
3. Update and examine the fit of BayCare’s readmission prediction model with the latest input factors.
4. Conduct a comparative analysis of BayCare’s readmission prediction model against another hospital site.
5. Disseminate the readmission research findings to BayCare and other appropriate organizations.

Methodology

Use logistics regression to predict 30-day readmission rates for BayCare patients. Construct an optimization model to establish patient risk classes and recommended discharge interventions for each patient class based on objective-based intervention characteristics, such as efficacy and cost. Build a web-based app for showcasing a Discharge Intervention Decision Support System that can convey effective and appropriate use of prediction and intervention recommendation models.

Potential Impact

To help mitigate partnering hospitals’ readmission risks by implementing patient-appropriate care transition strategies in order to improve the hospital’s quality of care and to have them avoid costly penalties.

Project Update

The research team has completed its investigation of the dynamics of the readmission prediction model. The team looked specifically
at the engine’s robustness in terms of the length of time before the accuracy of the model begins to significantly wane. Early indications showed the model would be valid for about two years. A more detailed analysis resulted in the break point being at 21 months. This is well beyond the time frame thought to be concerning. Operationally, it is expected that the model would be easily updated on at least an annual basis and could be done far more frequently than that, say quarterly, to take into account seasonal affects.

Based on feedback on the recently developed mobile app, the development team made a number of user interface edits. Out of this effort came the need to embellish the underlying prediction engine’s Python code. These changes, which have now been made, involved making the prediction model’s estimated risk and relative risk more congruent. The mobile app’s user guide was also revised to reflect these changes. Since then, the app has been disseminated to both the University of South Florida and Baylor Health, since people at both of these locations were involved in its development.

From an idea advanced in a recent readmissions’ webinar, the research team also examined the time to readmission for various diagnoses. This time is significant for if it is over 30 days, the hospital is not penalized. On the other hand, if it’s too short, say within a few days, enough time has not passed for the intervention to possibly take effect. Looking at the 10th percentile of the days to remittance across BayCare’s most frequent discharges, the diagnoses falling into this “actionable” state included schizophrenia, mood disorders, pulmonary disease and bronchiectasis, complications, and diseases of the heart.

Using claims data from St. Vincent Health MDwise Medicaid patients, the research team also studied the effect of post discharge care on 30-day readmission rates. The inpatients were mainly children and female adults. The team’s findings were that within 30 days of discharge:

- 14% of the discharges were followed by a primary care physician (PCP) visit
Project Update (cont.)

- 58% of the discharges were followed by a health care provider visit, where the provider included primary care physician, psychiatrist, psychologist or registered nurse practitioner

- A lower 30-day readmission rate occurred for non-obstetric pediatric patients, ages 1-17, who had seen a primary care physician within 30 days of discharge

- For females, the rate was 2% for those with PCP visits and 11% for those without PCP visits

- For males, the rate was 8% for those with PCP visits and 13% for those without PCP visits

On yet another note, Cleveland Clinic has come forward with interest in extending the center’s readmission study. In addition to the eleven hospitals studied at BayCare, Cleveland Clinic has given us data across nine of their hospitals, extending over a period of seven years. This will allow us to move more strongly into Phase D of our Research-to-Impact model. Ultimately, we look to perform a readmission comparative study of Cleveland Clinic and BayCare.

The research team worked with Cleveland Clinic’s Department of Quantitative Health Sciences to derive a mutually agreed upon master data list for Phase I, with the option to expand this list during the project to allow for additional clinical data to be included. The necessary IRBs at both Cleveland Clinic and Purdue have been approved. The team is now working on examining and cleaning this data.

Over the next time period, the team will be examining an analysis method that will segment readmission patients into more homogeneous subpopulations. This could help with the application of recommended interventions. We will also be working on identifying the most important variables in the readmission prediction model. This could play an important role when a discharge planner needs to run the mobile app with less than complete information. Investigating how changes in patient mix over time may affect readmission rates is also on the agenda to be studied.
Readmissions Study of Critical Access Hospitals

Research Team

Faculty
- Steve Witz, Regenstrief Center for Healthcare Engineering
- Yuehwern Yih, Industrial Engineering
- Zhiyi Tian, Regenstrief Center for Healthcare Engineering

Students
- Shan Xie, Regenstrief Center for Healthcare Engineering

Healthcare Partner
- St. Vincent Health critical access hospitals in Brazil, Elwood, North Vernon, Williamsport, and Winchester

Research Direction

Research Focus Area
- Care Coordination

Competencies
- Data analysis
- Modeling
- Statistical analysis

Research-to-Impact Phase
- Phase E (dissemination and evaluation)

Research Timeline
- 8/13: Completion of descriptive analysis
- 12/2013: Validation of Indiana research using HCUP data from Arkansas and Washington

Project Summary

Healthcare Problem
- Critical access hospitals (CAHs) operate under conditions dissimilar to short-term general acute hospitals subject to prospective payment reimbursement (PPS hospitals). They have a 96 hour limit on average patient length of stay, access to fewer local healthcare resources, and often provide a more limited scope of care than larger PPS hospitals. These conditions may lead to CAHs patients experiencing more frequent transitions in care, such as hospital readmissions. Transitions in care are associated with increased costs of care and poorer patient outcomes.

- Most hospital readmission studies have not included CAHs and thus there is uncertainty about the ability to apply these research results to CAHs since they are based upon hospital care that has some dissimilarity to CAH’s operating environment.
Research Objectives

1. Determine whether CAHs readmission profiles (numbers and types of readmissions) are similar indicating a set of common cause factors in CAH contributing to readmissions.
2. Determine if CAHs and PPS hospitals have similar readmission profiles.
3. Identify factors that are associated with CAH readmissions for the purpose of creating hypotheses pertaining to interventions that may be used in re-engineered care delivery processes at CAHs to reduce unnecessary readmissions and other situations of patient transition among care providers.
4. Validate research findings based on a sample of five critical access hospitals in Indiana using Arkansas and Washington HCUP data.

Methodology

Descriptive analyses of readmission experience and statistical comparison of CAH readmission rates; Logistic regression analyses of factors associated with readmissions in each CAH; and application of logistic regression models to establish individual hospital’s risk of readmission and comparison of hospitals based upon models of their readmission risks.

Potential Impact

This project will identify common patient transitions in care that may suggest inappropriate resource use, such as low primary care network usage among rural patients. The results may help rural Critical Access Hospitals to better coordinate care during patients’ transitions back into the community to reduce readmissions and non-urgent ED visits.

Project Update

1. Readmission rates among CAHs varied when compared to each other indicating that common cause CAH factors did not exist. This variance was found when comparing CAH readmission rates within a state, and when comparing rates across states. The inter-state variation followed the same variations as occurred for non-CAHs; readmission rates for CAHs and non-CAHs were the highest in Arkansas, followed by Indiana, with the lowest rates observed in Washington. These findings suggest that readmission rates are likely to be effected more by regional healthcare practices than by consistent influences associated with operational factors effecting CAHs.
2. Readmission rates in CAHs were lower than non-CAH hospitals within the states of Indiana, Arkansas, and Washington. This finding was contrary to the a priori expectation that limited healthcare resources in rural areas would increase the readmission rates for CAHs. These differences led to the conclusion that readmission profiles in CAHs and non-CAHs are not similar.

3. The factors most strongly associated with lower readmission rates in CAHs were the hospitals’ case mix. Indiana CAHs transferred a high percentage of patients with more complicated primary diagnoses. Between 30% and 50% of all patients presenting to Indiana CAHs and requiring hospitalization were transferred to hospitals with a greater scope of clinical services. Many of these transfers occurred directly from the CAH emergency department. The result was CAH patients had lower case severity and consequently lower risk for readmissions.

The role of CAH case mix was further evident when CAHs with an obstetrical service were compared to CAHs without obstetric services. Obstetrical patients in CAHs have a very low risk of readmission thus lowering hospital readmission risk. In Indiana, CAHs with obstetrical services had consistently lower readmission rates than CAH without obstetrical services.

We conclude that readmission interventions that are specific to the primary diagnoses and have been developed in non-CAHs are less applicable in CAHs due to these types of hospitals having different case mix.

There was similarity in the patients’ characteristics associated with increased risk for readmission in both CAHs and non-CAHs. For all patients readmission risk was increased with age, living alone, and frequency of previous hospital admissions. These findings indicate that when interventions are selected based upon patient characteristics, as opposed to clinical factors, there may be the ability to effectively apply interventions in both CAHs and non-CAHs. In other words, the social correlates of readmission are similar and should lead CAHs to look to those interventions targeting social factors that have been demonstrated to be effective in non-CAHs.
4. This study expanded its focus to look at patient care transitions in addition to readmission. These transitions include non-emergent emergency department use, ambulatory care sensitive conditions, and care for patients transferred to non-CAH upon return home. We conclude that these transitions represent a greater opportunity to improve community health than CAH readmissions. A common finding was that these transitions appeared to be most problematic in communities with reduced primary care physician-to-patients ratios.

This finding has led to the formation of hypotheses pertaining to the role of non-physician providers, CAH transition services to coordinate care for patients retaining home after being transferred to a non-CAH, and care coordination for patients admitted to CAHs with ambulatory care sensitive conditions. These hypotheses provide direction for further research to improve community health status in rural communities.

As this study progressed, the research team sought opportunities to disseminate the findings to impact rural healthcare delivery. An invited presentation was made at the Indiana Rural Hospital Association and a poster presented at the 2014 Association for Community Health Improvement national conference. A research report has been prepared for the Indiana CTSI and a paper is in final draft for submission for publication.
All-Cause Unplanned and Preventable Readmissions Reduction (ACUP-RR)

Research Team

Faculty
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Staff
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Xuanyao He, Regenstrief Center for Healthcare Engineering
Kit Klutzke, Regenstrief Center for Healthcare Engineering
Ken Musselman, Regenstrief Center for Healthcare Engineering
Rich Zink, Regenstrief Center for Healthcare Engineering

Healthcare Partner
Cleveland Clinic

Research Direction

Research Focus Area
Care Coordination

Competencies
Data Mining
Statistical Analysis
Project Management

Research-to-Impact Phase
Phase B (research and model development)

Research Timeline

Project Summary

Healthcare Problem
Unplanned and preventable readmissions to hospitals within 30 days after discharge are driving excessive healthcare cost for patients and providers. Reducing unplanned 30-day readmission is an opportunity for many hospitals to improve quality of care and reduce the penalty stipulated by the Affordable Care Act.

Research Objectives
1. Determine 30-day unplanned and preventable readmission rate by hospital by specialty cohort.
2. Develop a prediction model for the 9 CC hospitals in NE Ohio based on hospital characteristics, patient characteristics, and patient care information.
3. Identify transitional care services that are strongly associated with absence of unplanned and preventable readmissions.
4. Analyze discharges by primary diagnosis, discharge disposition, and payor type to identify where there are high readmission rates and patients that stay out of the hospital long enough for the healthcare provider to do something about it in an outpatient setting.

5. Determine how well does the Baycare risk prediction model predict readmission outcome using CC’s data.

**Methodology**
For objective 1, the statistical models developed will be based on one year’s admissions data. For objective 2-5, the statistical models developed will be based on at least 2 years data. For objective 3, data mining will be used to segment the patient population and logistics regression will be used to predict the “effectiveness” (odds of not being readmitted) of care transition service clusters of interest.

**Potential Impact**
Improve quality of patient care in order to reduce unnecessary 30-day readmissions, healthcare utilizations and cost of care.

**Project Update**
We received data from the hospital on 3/13/14. Since then, we have been reviewing, validating and cleaning the data. We are currently processing the data to prepare it for statistical analysis which is estimated to complete in June 2014. We are looking for someone to replace a team member who was targeted to complete objective 1. Literature review on transitional care services (objective 3) is being conducted by our intern. An interim presentation was made on April 15, 2014.
Project Summaries

Transitions in Care Pilot: Hospital to SNF/LTPAC

Research Team

Faculty
Benjavan Upatising, Regenstrief Center for Healthcare Engineering
Steve Witz, Regenstrief Center for Healthcare Engineering and Health Science

Healthcare Partner
Michiana Health Information Network

Research Direction

Research Focus Area
Care Coordination

Competencies
Statistical analysis

Research-to-Impact Phase
Phase B (research and model development)

Research Timeline

Project Summary

Healthcare Problem
Effective patient transitions require communication among healthcare providers pertaining to the patient’s condition and treatment plan. The hospital discharge summary and referral request are common communication formats for the exchange of this information. Previous reported research documents that these types of communication may not occur, may not occur in a timely manner, or may be missing critical information. These communication limitations are associated with ineffective care transitions and care coordination.

Research Objectives
Develop and pilot a model of automating the exchange of critical information required to coordinate patients’ care during transition.

Methodology
1. Secure patient transition report development and distribution utilizing clinical data base structures and direct communication.
2. Patient readmission risk projection
3. Statistical analyses

Potential Impact
The improved communication made possible through this project may result in 1) increased provider satisfaction with the availability and quality of clinical information, and 2) a reduction of hospital readmissions among patients discharged to a SNF or LTPAC facility.

Project Update
Data collection is in progress for this research.
Project Summaries

Bioengineering and Population Health

Research Team

Faculty
Vince Duffy, Industrial Engineering

Healthcare Partner
Roudebush VAMC

Research Direction

Research Focus Area
Care Coordination

Competencies
Human factors
Modeling

Research-to-Impact Phase
Phase B (research and model development)

Research Timeline
2013–2014 (estimated)

Project Summary

Healthcare Problem
The coordination of care for patients in the Veteran Affairs (VA) is exacerbated by difficulties in scheduling patients requiring longitudinal care who reside in geographic settings distant to VA Medical Centers and from multiple care providers. Scheduling systems in use at the VA Medical Centers can be improved to enable higher reliability in the delivery of care at appropriate times.

Research Objectives
This project intends to assist Veteran Affairs (VA)-Center for Applied Systems Engineering in the analysis and improvement of healthcare delivery systems and processes through the development and use of smart device-based applications targeted at reducing patient no-show rates and helping with cancellation and rescheduling. An innovative communication channel will be developed and implemented between the VA Medical Center and veteran patients to facilitate information flow including reminders, confirmation, request and responses, and appointment management with more patient involvement. Data available through GPS systems may give early indicators of likelihood of arrival in a real-time, flexible and dynamic patient care system. The new data can be used for future analysis and tuning system parameters.
### Methodology
This project uses the following methodologies:
1. Secure patient transition report development and distribution utilizing clinical database structures and direct communication.
2. Patient readmission risk projection
3. Statistical analyses

### Potential Impact
If more patients are able to schedule and reschedule appointments through the application, it can reduce no-show rates and improve appointment rates. This would reduce wait times and improve care if patients are able to make appointments they can keep.
Transition From Hospital Care: Managing Type 2 Diabetes

Research Team

Faculty
- Melissa Franks, Human Development and Family Sciences
- Cleveland Shields, Human Development and Family Sciences
- Steve Witz, Regenstrief Center for Healthcare Engineering

Students
- Amber Seidel, Human Development and Family Sciences
- Justin Briggs, Human Development and Family Sciences
- Z. Seda Sahin, Human Development and Family Sciences
- Christina Marini, Human Development and Family Sciences
- Mary Marshall, Human Development and Family Sciences
- Elizabeth Wehrspann, Human Development and Family Sciences
- Natasha Brown, Communication

Healthcare Partner
- Beverly L. Reed, St. Vincent Health

Research Direction

Research Focus Area
- Care Coordination

Competencies
- Dyadic communication
- Patient-provider communication

Research-to-Impact Phase
- Phase C (single-site pilot)

Research Timeline
- 8/1/12–12/31/13 (projected)

Project Summary

Healthcare Problem
Points of transition and needed coordination and communication have been found to be common problems in preventable readmissions. Absence of patient and family education at discharge is associated with a greater than twofold increase in risk of avoidable readmission. Thus, efforts to improve the ability of patients to apply the discharge instruction during the transition from the hospital to home appear to offer significant value in minimizing adverse events during this time.

It increasingly is recognized that individual successes and failures in managing chronic illness are likely to be shaped by important social partners. Thus, we seek to investigate the involvement of key family members as patients’ transition from hospital care to care at home...
or another facility. This investigation of transition from hospital care will include examination of education provided to family members as patients prepare for hospital discharge.

**Research Objectives**

This study examines interactions in the medical space that may facilitate proper management of diabetes upon hospital discharge and reduce the likelihood of short-term readmission to hospital care.

**Methodology**

This study uses a survey study of patients and support partners to examine experiences in the hospital and at home (prior to admission) as factors associated with likelihood of readmission.

**Potential Impact**

Understanding the support partner’s role in care and potential readmission can allow providers to make decisions about how they should be included in transition of care discussions.

**Project Update**

After experiencing significant bureaucratic delays, the project began patient and support partner recruitment. The recruitment procedures were revised after the original implementation was unsuccessful; nurses were not comfortable discussing the study with patients as they had originally planned.

Twenty three patient-partner dyads were ultimately recruited for this study. Although the sample is small, the results point to some interesting findings that have piqued interest and may be the starting point for a second study. 16 of the pairs were spouses; the other 7 were unmarried support partners (children, etc.) living in the same house.

Existing readmissions research indicates that a patients’ marital status is a statistically significant factor in predicting their likelihood of readmission. This research indicates that a spouse is not more helpful in reducing readmissions than an unmarried support partner who lived with patients. Patients with a spouse also reported less distress in dealing with their disease than those who had a support partner. This suggests a need to clarify the supportive roles of spouses versus support partners in reducing readmissions.

Patients were followed for 90 days after discharge. Those with diabetes only were not readmitted. Patients with diabetes and other chronic conditions, however, were.

The researcher is exploring a larger study and the logistics to do that.
Project Summaries

Integrated Trauma Data for Outcomes Research

Research Team

*Faculty*  
Joseph Thomas III, Pharmacy Practice

*Healthcare Partner*  
Indiana State Department of Health  
Rehabilitation Hospital of Indiana

Research Direction

*Research Focus Area*  
Population Health

*Competencies*  
Data analysis  
Outcomes research

*Research-to-Impact Phase*  
Phase B (research and model development)

*Research Timeline*  
2010–2015 (estimated)

Project Summary

*Healthcare Problem*  
Separate data can sometimes hide relationships between care delivery and outcomes. This project links four data sources representing information on trauma care delivery and health outcomes to examine variations in care and their effects.

*Research Objectives*  
The project seeks to link trauma registry data, EMS run data, and hospital discharge data to characterize trauma in Indiana and to enhance the state’s ability to conduct outcomes research on trauma and to improve the trauma care system. The large data sets in this project enable a focus on outcomes instead of mortality and provide the ability to perform more longitudinal analyses.

*Methodology*  
This project attempts to link four data sources: Indiana trauma registry, Indiana Emergency Medical Services registry, Indiana hospital discharge data, and Medicaid data for cases in the Indiana trauma registry.

*Potential Impact*  
Improve the outcomes of trauma patients who require rehabilitative care by better coordinating acute and rehab care facilities.
Project Summaries

Employer Sponsored Wellness Programs: Improvements in Participants’ Health Status

Research Team

**Faculty**
- Xuanyao He, Statistics and Actuarial Science
- Michael Busk, St. Vincent Institute for Health, Wellness and Prevention
- Stephanie Collins, St. Vincent Institute for Health, Wellness and Prevention
- Steve Witz, Regenstrief Center for Healthcare Engineering, Health Science

**Healthcare Partner**
- St. Vincent Institute for Health, Wellness and Prevention

Research Direction

**Research Focus Area** Population Health

**Competencies**
- Statistical analyses
- Cost-benefit analyses

**Research-to-Impact Phase** Phase B (research and model development)

**Research Timeline** 10/2013–12/2014

Project Summary

**Healthcare Problem**
The employer is a major source of funding for employee’s health insurance. The rapidly increasing cost of health benefit plans is causing many employers to question their ability to continue to afford health benefits as currently offered. One option employers are considering is work-site clinics with programs to address employee wellness. There are mixed results reported about the value of these programs leaving many employers with uncertainty about the value of work-site health services and wellness programs.

**Research Objectives**
Provide evidence of the value of employer-based health services and wellness programs.

**Methodology**
Employers participating with the St. Vincent Health, Wellness and Prevention Institute will serve as case studies. Pre and post evaluation models will be used to determine the change in health status, utilization of health programs and satisfaction.
**Potential Impact**

Improve the employer’s ability to create a culture of wellness and promote improved health status of employees in their health programs.

**Project Update**

An employer working with St. Vincent Health, Wellness and Preventive Care Institute has agreed to participate as the pilot organization. We estimate approximately 1,200 employees and their dependents will be included in the evaluation of this employer’s health benefit plan.

An initial set of questions has been developed with input from the employer, St. Vincent, and RCHE. These questions will guide the evaluation efforts. The data needed to answer these questions and the sources of these data has been identified. We are in the process of developing separate business associate agreements with each of the organizations serving as a data source to enable data to be transferred to RCHE. A process for matching data from four different sources has been developed to provide an integrated set of information for each employee and dependent. After data matching, the integrated data will be formatted as a limited data set to improve patient information confidentiality.

St. Vincent and RCHE have identified two additional employers and begun discussions with them to secure their participation in this research.

Currently, data collection from St. Vincent Institute for Health, Wellness and Prevention in progress.
Project Summaries

Rural Community Healthcare Utilization: Changes Resulting from Improved Access to Primary Care

Research Team

Faculty
Xuanyao He, Statistics and Actuarial Science
Steve Witz, Regenstrief Center for Healthcare Engineering and Health Science

Healthcare Partner
St. Vincent Health System
Williamsport Hospital

Research Direction

Research Focus Area
Population Health

Competencies
Statistical analyses

Research-to-Impact
Phase B (research and model development)

Research Timeline

Project Summary

Healthcare Problem
Many rural communities experience shortages of healthcare resources; frequently, primary care providers. These shortages are reported as necessitating patients to seek care outside of their community. As patients migrate outside of their community, a critical mass of local healthcare demand is reduced threatening the viability of local providers and ultimately geographical access to local healthcare services.

Research Objectives
This study assesses local access to primary care in one rural community and the resulting patterns of healthcare utilization when primary care out-migration occurs. The study models the implication of expanding local primary care provider capacity on healthcare utilization patterns. Inferences are made to the potential quality implications of out-migration for primary care services.

Methodology
Statistical analyses of population utilization data. Primary data is being provided by the healthcare partners.
**Potential Impact**

If improved access to primary care leads to better health outcomes, as identified through this project, the research could be a first step in developing lower cost, better coordinated care.

**Project Update**

Initial assessment indicated that education and healthcare were among the high priority areas for local economic improvement. Working with Williamsport Hospital and St. Vincent Health, several local employers agreed to provide employee claims data to support modeling healthcare utilization and an assessment of adequacy of local healthcare services.

Preliminary analyses have been completed on employer claim data from five employers: Harrison Steel, TMF, Fountain County School System, Truflex and Warren. Due to a high percentage of missing values in several counties’ datasets, the most interpretable results we obtained are from Harrison Steel and TMF. The scope of analyses can be summarized as follows:

1. Analyses of allowed charge (cost to employers) by primary diagnosis, with five components each: Inpatient, Outpatient, ER, Office and Other. Every claim’s primary diagnosis/procedure code has been clustered into one of a manageable number of clinically meaningful categories, by AHRQ’s Clinical Classification Software (CCS), a “clinical grouper” tool.

2. Identification and comparison of charges by provider, i.e. primary care (PCP) vs. specialty, hospital vs. non-hospital facilities, and inpatient vs. outpatient services, from both volume and payments aspects. In particular for the Primary care office visits, we also separate them into five types: Family Practice, General Practice, Medicine, Pediatric and Nurse Practitioner and compare their payments and volume percentages.

3. Identification of outlier (patients) for each employer/county, and the corresponding condition categories.

In response to this evaluation, two actions have been taken: (1) primary care physicians and clinics within the St. Vincent Health clinic changed hours of operation to provide services at peak hours of demand; and (2) Harrison Steel started a work site clinic.
Harrison Steel and their insurance broker, Paradigm, Inc., have asked RCHE to continue to work with them to assess the impact of the worksite clinic on primary care availability and pilot the population health model being developed at RCHE. New data is being collected to support this evaluation. Data use agreements have been recently established allowing access to these data and RCHE is anticipating data exchange by the end of March.

Possible following research areas include:

1. Identify the most prevalent chronic disease listed as primary/secondary diagnoses and the total and median allowed charges by chronic diseases.

   1. Secondary analyses would involve:

      1. The patient/provider adherence to preventive care related to the primary diagnoses, and

      2. The patient/provider adherence to the evidence-based care for the chronic conditions.

   2. Secondary analyses to assess the extent of avoidable utilization:

      1. Non-urgent use of the ER;

      2. Hospital admissions for ACSCs;

      3. Hospital readmissions;

Comparison of St. Vincent total allowed charges to non-St. Vincent charges for frequent and similar diagnoses.

Currently, data collection from Paradigm/HarrisonSteel is in progress.
Primary Care Appointments for Diabetic Patients: Cross Sectional Comparisons of Patients Who Cancel and Those Who No-Show

Research Team

*Faculty*
Mark Lawley, Biomedical Engineering
Laura Sands, Nursing
Sara McComb, Nursing
Lingsong Zhang, Statistics

*Staff*
Zhiyi Tian, Regenstrief Center for Healthcare Engineering

Research Direction

*Research Focus Area*
Population Health

*Competencies*
Statistical analysis

*Research-to-Impact Phase*
Phase B (research and model development)

*Research Timeline*
2013–2015

Project Summary

*Healthcare Problem*
Patients scheduled for primary care appointments tend to observe certain behaviors from one appointment to another (attend, cancel, or no-show). This pattern affects continuity of care in addition to altering the managerial view on appointment behaviors, as has been documented in the literature.

*Research Objectives*
This study is to measure scheduling, appointment, emergency department (ED), and hospitalization behaviors following an index appointment for diabetic patients.

*Methodology*
Conduct a cross sectional study to examine primary care appointment behavior among 7,586 adult diabetic patients attending outpatient clinics associated with a medical center in Indiana. The examined outcomes are scheduling & attending behavior, days to reschedule, and ED visits & hospitalization in the six months following index appointment. Scheduling and billing data and Regenstrief Medical Records System (RMRS) data are linked to retrieve the information of appointments and ED and Hospital usage.
Potential Impact

Understanding the scheduling behavior difference can improve clinic efficiency and patient care.

Project Update

Patients scheduling information and ED and hospital utilization have been linked through common patient ID. Data have been reviewed and went through data processing. Appointments within one year period for diabetic patients who aged 18 years and older were included for study sample. Data have been evaluated to ensure patients have been diagnosed with diabetes at least twice, have a history of provider visits, not be a one timer within the clinic system, and have health records in Regenstrief Medical Records System both within one year prior to and within one year after the last scheduled appointment so ED and hospitalization utilization information will be available for comparison.
Project Summaries

Proactive Planning and Scheduling Intervention for Diabetic Care

Research Team

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Lingsong Zhang, Statistics

Staff
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Kumar Muthuraman, University of Texas, Austin, Scheduling Consultant

Students
Nikhita Dulluri, Computer Science
Michael James, Biomedical Engineering

Healthcare Partner
Alliance of Chicago Community Health Service, LLC
IU Health-Arnett (Dr. Shannon Oates, endocrinology)

Research Direction

Research Focus Area
Population Health

Competencies
Statistical analysis
Schedule modeling
Risk modeling

Research-to-Impact Phase
Phase C (single-site pilot)

Research Timeline
2011–2013 (estimated)

Project Summary

Healthcare Problem
This project extends the no-show scheduling work of Drs. Lawley and Sands and applies it to an EMR, testing and validating the impact of the research.

Regular endocrinology visits can significantly assist diabetic patients in managing this chronic condition. Patients who miss appointments are at a greater risk of having difficulty managing their condition. Additionally, accommodating no-show patients
creates scheduling difficulties for the clinic, resulting in lost productivity, longer wait times, and reduced reimbursements.

This research line draws on prediction and modeling to create a scheduling algorithm for a clinic that better manages patient no-shows and thus reduces wait time and improves productivity and reimbursements.

**Research Objectives**

1. Implement the research algorithm in a clinic setting through an EMR
2. Run clinical trials through the EMR using the clinic population
3. Validate the impact of the no-show/scheduling research on improving clinic scheduling and attendance.

**Methodology**

The Centricity EMR will be used to implement the scheduling algorithm, which will be tested in a clinic in the Chicagoland area. The clinic will provide data to the research team for analysis.

In a second phase, Dr. Shannon Oates will provide longitudinal daily blood glucose data for the early stages of analysis and modeling. This will assist in the development of risk modeling based on these levels and state transition modeling for classes of diabetes patients.

**Potential Impact**

The algorithm in this research could help reduce wait times and improve clinic productivity and reimbursements by reducing no-shows. It would also help identify patients at a greater risk than others of not showing up to their next appointment, thus enabling the provider team to pre-emptively address that.
Project Summaries

Analyzing Healthcare Utilization to Support Accountable Care Delivery

Research Team

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*Staff*
Ken Musselman, Regenstrief Center for Healthcare Engineering
Mike Zentner, ITaP/Rosen Center for Advanced Computing
Ping Huang, Regenstrief Center for Healthcare Engineering

*Students*
Wei Liu, Industrial Engineering

*Healthcare Partner*
OurHealth

Research Direction

*Research Focus Area*
Population Health

*Competencies*
Data analysis
Modeling
Interactive data exploration

*Research-to-Impact Phase*
Phase C (single-site pilot)

*Research Timeline*
6/18/12–2014 (projected)

Project Summary

*Healthcare Problem*
The Regenstrief Center for Healthcare Engineering (RCHE) is collaborating with OurHealth to develop a decision support tool to improve the health of company communities.

RCHE has developed a prototype decision support model for healthcare providers working to improve quality and cost savings. The ultimate goal of this initiative is to develop a decision support capability that healthcare providers can use to improve their healthcare quality and cost savings. The project seeks to support this overall initiative by conducting exploratory research to investigate the value-added benefits derived by driving a medical management decision support tool, namely the Utilization Model, with claims information and systems expertise from OurHealth.
**Research Objectives**

1. Evaluate data availability and technology opportunities associated with OurHealth functioning as an information source for the operation of the Utilization Model.

2. Pilot the application of the Utilization Model in OurHealth’s primary care clinics in an effort to improve their ability to identify and prioritize sound, evidence-based medical management strategies.

3. Collaborate with OurHealth to develop and assess additional applications of the Utilization Model to possibly expand the scope of benefit to their customers.

**Methodology**

Develop a formal definition of the OurHealth Utilization Model and its required data elements. Upload and validate the transfer of the data elements from the OurHealth system, filtering the elements as appropriate. Develop the OurHealth Utilization Model, parameterizing it for two of OurHealth’s sites. Validate the model against the available raw claims data from Anthem. Work with OurHealth to understand the appropriateness and usefulness of the model’s user interface and output.

**Potential Impact**

To improve accountable care delivery effectiveness through the improved selection and adoption of clinic-specific medical management strategies.
Project Summaries

Analyzing Healthcare Utilization to Support Accountable Care Delivery (Pilot: OurHealth)

Research Team

Faculty
Steve Witz, Regenstrief Center for Healthcare Engineering and Health Science

Staff
Ken Musselman, Regenstrief Center for Healthcare Engineering
Mike Zentner, ITaP/Rosen Center for Advanced Computing
Ping Huang, Regenstrief Center for Healthcare Engineering
Kit Klutzke, Regenstrief Center for Healthcare Engineering

Students
Wei Liu, Industrial Engineering
Hambisa Keno, Industrial Engineering

Healthcare Partner
OurHealth

Research Direction

Research Focus Area
Population Health

Competencies
Data analysis
Modeling
Interactive data exploration
Cluster analysis

Research-to-Impact Phase
Phase C (single-site pilot)

Research Timeline
3/1/2014–12/31/2014

Project Summary

Healthcare Problem
RCHE is collaborating with OurHealth to develop a decision support tool to improve the health of company communities to improve their quality of care and cost effectiveness. This research seeks to support this overall initiative by performing clinical analytics to identify medical management strategies that will improve population health in targeted areas through the use of a medical management decision support tool. The process will leverage OurHealth's clinical knowledge with claims and biometric information coming from OurHealth’s patient population to identify those patients whose outcomes will benefit the most from intervention efforts and better informed choices.
Project Summaries

Research Objectives

1. Evaluate data availability and technology opportunities associated with OurHealth functioning as an information source for the operation of the Population Health Model.
2. Verify the Data Input Processor accurately captures insurer input.
3. Establish appropriate health metrics to support the stratification of OurHealth's patient population.
4. Investigate various approaches to patient risk stratification that will improve OurHealth's ability to identify and prioritize sound, evidence-based medical management strategies.
5. Evaluate the model's effectiveness in providing actionable steps for providers to pursue better accountable care delivery.
6. Disseminate the research findings to OurHealth and other appropriate organizations.

Methodology

Upload and verify the transfer of the data elements from the OurHealth system to drive the Population Health Model, filtering the elements as appropriate. Parameterize the model to best address the environment and then work with OurHealth to understand the appropriateness and usefulness of the model in determining targeted medical management strategies for this population.

Potential Impact

To improve accountable care delivery effectiveness through the improved selection and adoption of clinic-specific management.

Project Update

The team has successfully completed the initial project with OurHealth and is now extending it to a second phase. The team has received pharmaceutical data from CVS for one of the companies OurHealth supports. The team has been actively working with OurHealth on examining various stratification techniques in support of assessing the health status of their patient population. OurHealth has provided their clinical data to help us in establishing a stratification approach.

The research team conducted a preliminary analysis against Medical Expenditure Panel Survey (MEPS) data. A comparison was made against MEPS' national and regional private insurance data. In nearly all cases, the OurHealth averages were less. The second analysis looked at OurHealth patients who are considered "at risk." These patients fall into a specific biometric classification defined by OurHealth. Through analyses such as this, it is expected that OurHealth will be able to better understand how they should target their care to this population.
Social and Behavioral Influences on Clinical Communication and Pain Management

Research Team

Faculty
Cleveland Shields, Human Development & Family Studies
Ronald Epstein, University of Rochester Medical Clinic

Research Direction

Research Focus Area
Population Health

Competencies
Health disparities
Physician-patient communication

Research-to-Impact Phase
Phase B (research and model development)

Research Timeline
2011–2016

Project Summary

Healthcare Problem
Compared to white patients with advanced cancer, black patients experience inferior pain control and less frequent and less effective discussions about symptoms, prognosis and treatment preferences. It is not clear the degree to which these differences are due to patient factors (e.g. asking fewer questions) or physician factors (e.g. implicit/unconscious racial bias, poor communication). Preliminary studies suggest that activating patients to be more assertive and to ask more questions during the visit can mitigate racial differences in communication and pain management. The proposed study addresses this critical question through a field experiment. Using novel standardized patient methodology, we will randomly assign black or white patients with identical cancer history and symptoms to primary care and oncology physicians to examine whether potentially mutable patient and physician behaviors (activation and patient-centered communication) might mitigate some of these racial differences, including those that are due to implicit biases.

Research Objectives
1. To examine the magnitude of racial differences in physicians’ assessment of pain, discussions about prognosis and treatment choices, and use of guideline-concordant pain management.
2. To examine whether patient activation mitigates racial differences in physician communication behaviors and pain management decisions.
3. To explore potential moderators of racial differences in physician communication behaviors and pain management decisions, such as patient-centered communication and implicit unconscious bias.

**Methodology**

This project uses “secret shopper” patients — unannounced standardized patients portraying identical scenarios. The patients differ only in race and in level of patient activation. Providers will be randomly assigned two of these patients over a 12-month period but differing according to activation.

Depth of physician pain assessment will be coded with the Measure of Physician Pain Assessment. Prognosis and treatment choice communication will be coded using the Prognosis and Treatment Choices measure. Patient-centered communication that has been associated with prescribing behavior will be assessed through an Exploring and Validating Concerns component. Implicit Associations Test will be used to examine any biases for moderating effects.

**Potential Impact**

The results of this study could provide tools for patients and providers to use to help reduce the impact of race bias and assist minority patients in obtaining the care and treatment they need.

**Project Update**

The following papers in association with this project are in press:


Geospatial and Sociodemographic Analyses of Health-care Seeking Behavior Within Safety Net Providers

Research Team

Faculty
Steve Witz, Regenstrief Center for Healthcare Engineering, Health Sciences
Xuanyao He, Statistics and Actuarial Science
Lingsong Zhang, Statistics
Christopher Miller, Library Science
Haslyn Hunte, Public Health, University of West Virginia

Students
Angelitta Britt, Health and Kinesiology
Shauna Stapleton, Health and Kinesiology
Elizabeth Dobis, Agricultural Economics

Healthcare Partner
Wishard Hospital
Regenstrief Institute

Research Direction

Research Focus Area
Population Health

Competencies
Geospatial analysis
Statistical analysis

Research-to-Impact Phase
Phase B (research and model development)

Research Timeline
8/2013–10/2016

Project Summary

Healthcare Problem
This research is conducted to provide fundamental information about issues affecting how patients seek care from the core safety net providers in Marion and surrounding counties. It is intended as an initial research effort contributing information about patients’ care seeking behavior, gaps in available information, and assessment of the value of this information for planning core safety net services.

Research Objectives
This study will provide leaders and policy makers for the core safety net providers in the Marion and surrounding counties with information pertaining to where uninsured and under-insured patients go to seek care. Analyses will be coordinated to identify factors influencing care seeking behavior and model changes in
care seeking behavior as these factors change. This information will support the core safety net providers planning and systems operation.

*Methodology*

Geospatial Analyses

Statistical analyses of patient utilization data

*Potential Impact*

By identifying the characteristics of providers who are constantly selected for care, this research can enable other providers to serve the identified needs of these patients in non-emergent settings. Developing consistent primary care relationships with trusted providers could then lead to better coordinated care.

*Project Update*

A meeting with Mike Zentner and Nathan T Denny is scheduled (May 12th) to illustrate methodology for geo-coding “distances” from individuals to providers, introduce the general background of Census & ACS data and particularly the ACS data collection methods and what the semantics of the columns.
Project Summary

Patient Sexual Orientation Disclosure to Medical Providers

**Research Team**

*Faculty*
- Cleveland Shields, Human Development & Family Studies
- Maria Venetis, Brian Lamb School of Communication
- Beth Meyerson, School of Public Health, Indiana University

*Healthcare Partner*
- Indiana Minority Health Coalition Inc. (IMHC)

**Research Direction**

*Research Focus Area*
- Population Health

*Competencies*
- Health disparities
- Physician-patient communication
- Disclosure theory

*Research-to-Impact Phase*
- Phase B (research and model development)

*Research Timeline*
- 2013–2014 (projected)

**Project Summary**

*Healthcare Problem*
- Research reports that members of the LGBTQ population can be hesitant to disclosure their sexual orientation or behaviors. Reasons for disclosure avoidance include the potentially faulty perception that the information is not relevant to their health care, fear of negative provider reaction, fear of discrimination, and being unsure of how to share that information. Additionally, current theories of disclosure focus on disclosure of stigmatized information and nonvisible health information; additionally these theories define the disclosure recipient as a relationally close other (rather than a medical provider). We seek to determine if and how current theories are relevant to the disclosure of sexual orientation.

*Research Objectives*
- This is the first stage of a larger, ongoing project with IMHC. The research objectives for this stage are:
  1. To examine young adults’ experiences with disclosure of sexual behavior/orientation to healthcare providers; and
  2. To examine to the congruence of disclosure of sexual behavior/orientation to healthcare providers with existing theories of disclosure.
### Methodology
The researchers will conduct interviews with approximately 20 members of the Indiana LGBTQ community.

### Potential Impact
This project will contribute to a larger research project with IMHC. The larger project will help draw attention to the needs of the LGBTQ community as a minority health group.

### Project Update
Funding from IMHC was received. Interviewers have been recruited and are being trained for data collection.
Research Team

Faculty
Mohan Dutta, Communications
Bart Collins, Communications
Titilayo Okoror, Binghamton University

Healthcare Partner
Indiana Minority Health Coalition

Research Direction

Research Focus Area
Population Health

Competencies
Health disparities
Health communication
Community building

Research-to-Impact
Phase E (dissemination and evaluation)

Research Timeline
2010–2014

Project Summary

Healthcare Problem
Comparative effectiveness research summary guides provide excellent summaries of the evidence comparing methods for treating a wide range of medical conditions. However, despite the potential relevance of research guides to underserved populations, they are likely to have little impact on the health of those populations, for reasons including: 1) Language: Both health literacy and English proficiency are often limited, making the research guides difficult to understand; 2) Examples: In their current form, research guides do not offer specific examples and role models; 3) Delivery Mechanism: Because underserved populations often have less access to clinical information on the internet and less exposure to the health care system; and 4) current mechanisms (such as the Internet) for making research guides available to the public are unlikely to reach these groups.

Research Objectives
This project will develop research guides on heart disease targeted toward African Americans in Indiana, given the existing disparities among racial/ethnic groups in the area of heart disease, and its prevalence among African Americans in the state of Indiana.
Project Summaries

1. Develop and test culture-centered approaches for training local leaders and members of African American communities on how to tailor comparative effectiveness research guides related to hypertension and how to develop a strategy for creating awareness of these tailored research guides that will work in their local context.

2. Develop and test a health disparities hub that can be assessed by community leaders and members seeking to tailor research guides and distribution mechanisms for their local populations.

3. Increase the use of tailored hypertension research guides in underserved African American communities in Indiana.

Methodology

The study uses a combination of the participation-based culture centered approach and message tailoring methods to develop a framework for the development, implementation, evaluation and sustenance of adjusted research guides. These methods include focus groups, in-depth interviews, and tailoring workshops to engage the local communities in the identification of criteria and the development of tailored messages from within the communities.

The health disparities hub was developed using Purdue’s HubZero platform. A baseline survey and a post-intervention survey will be used to assess the impact of the project.

Potential Impact

The CUAHD project is developing guidelines and resources for other communities interested in developing culture-centered approaches to healthcare challenges. These will become part of the AHRQ toolkit library and will be available online. It is hoped that these tools will allow others to achieve similar results in shorter time periods and with less initial research needed.

Project Update

The three-year funding cycle from AHRQ ended in August 2013. Initial results from data analysis indicated that the Marion and Lake community participants evidenced significantly greater understanding of heart-health information than our control community. Current work is focused on preparation of manuscripts for publication for submission to peer-reviewed journals as a part of the dissemination strategy. The manuscript for the primary quantitative analysis of the health campaign data is being initially targeted for *The Journal of the American Medical Association*. Other manuscripts detailing the results of the qualitative analyses are also being planned.
Human-Robotics Interaction Initiative for Enhancing Participation of Persons with Disabilities in Healthcare and STEM Educational Activities

Research Team

Faculty

Brad Duerstock, Biomedical Engineering

Research Direction

Research Focus Area

Population Health

Competencies

Human-robotics interaction
Ergonomics

Research-to-Impact Phase

Phase C (single-site pilot study)

Research Timeline


Project Summary

Healthcare Problem

Individuals with physical disabilities often encounter barriers in the use of scientific instruments essential in training and performance of scientific and health activities. These barriers impede the ability to develop skills necessary to gain scientific proficiencies and contribute to the development of new knowledge. Additionally, these barriers limit the ability of those with disabilities to function as independent scientists and attain greater self-sufficiency.

Research Objectives

The research will enable persons with disabilities to perform healthcare and vocational activities more independently and effectively through the help of robotic aids. The proposed human-robotic interaction devices will include mobile robots to transport materials, robotic arm to manipulate items and perform tasks, and remotely-operable, robotic microscopy work station.

Methodology

The researcher will develop, test, and evaluate robotic aids to achieve the objectives of this study.

Potential Impact

Enabling those with physical disabilities to engage in the sciences positively contributes to the STEM workforce and overall employment opportunities.
Project Summaries

Affecting Cancer Together

Research Team

Faculty
Teresa Thompson, Comprehensive Cancer Center
Cleveland Shields, Human Development and Family Studies

Healthcare Partner
Community Cancer Health Advocacy Groups in Indiana and Lay Educators

Research Direction

Research Focus Area
Population Health

Competencies
Community-centered research
Statistical analyses
Lay community involvement in education and prevention

Research-to-Impact Phase
Phase D (multiple-site pilot study and evaluation)

Research Timeline
1/2011–1/2014

Project Summary

Healthcare Problem
The reduction in cancer morbidity and mortality is dependent upon effective public programs for cancer awareness, prevention and screening. Limited public knowledge and ineffective messaging, particularly for underserved communities, have led to disparities in cancer incident rates among certain population groups.

Research Objectives
1. Prevention of cancer and other chronic diseases in Indiana through awareness and education, providing a bridge to health resources and services, as well as developing health leaders, lay health educators, and health motivators in the community.

2. Improve health outcomes for all, including underserved populations.

Methodology
Non-traditional health care settings in the community are utilized to promote awareness, educate about, motivate and encourage prevention and early detection of cancer and chronic diseases. There is focus on integrating the community’s input and feedback into ACTion.

Potential Impact
Increased awareness of cancer screenings and resources can potentially contribute to early catches and improved health outcomes.
Project Summaries

Optimizing Ambulance Positioning to Reduce Response Time

Research Team

Faculty
Maria Shunko, Operations Management, Krannert School of Management
Daniel O’Donnell, Emergency Medicine, IU Medical School
Ping Huang, Regenstrief Center for Healthcare Engineering

Student(s)
Angelica Rodriguez, Krannert School of Management
Xiaoyang Chen, Krannert School of Management
Harshal Samant, Krannert School of Management
Yini Peng, Krannert School of Management
Kashif Khan, Krannert School of Management

Healthcare Partner
Marion County EMS

Research Direction

Research Focus Area
Emerging research interests

Competencies
Operational research
Optimization
Geospatial analysis

Research-to-Impact Phase
Phase A (healthcare system evaluation with stakeholder input)

Research Timeline
1/2014–6/2014

Project Summary

Healthcare Problem
Ambulance response time to medical emergencies is a key metric in evaluating the effectiveness of a regional emergency medical system. Positioning of ambulances and crews while not involved in making a response is felt to be a key determinant in reducing response times to an emergency.

Research Objectives
Apply operational management techniques and modeling to determine optimum ambulance location to reduce response times.

Methodology
This project uses operational research and optimization methodologies.
**Potential Impact**

Reducing ambulance travel distance and time means EMS crews could get to emergencies and back to hospitals more quickly. It also aims to help keep EMS crews safe by requiring them to travel fewer miles, thereby reducing the potential for accidents.

**Project Update**

The research team met with the EMS personnel to clarify the project details. Data has been obtained from Marion County EMS, along with encryption requirements. HIPAA certification has been completed and the data has been set up on RCHE's HIPAA-aligned server.
**Project Summaries**

**Gestonurse: A Robotic Surgical Nurse for Handling Surgical Instruments in the Operating Room**

**Research Team**

*Faculty*
Juan Wachs, Industrial Engineering

*Student(s)*
Yu-Ting Li, Industrial Engineering
Mithun Jacob, Industrial Engineering
Sid Paridas, Industrial Engineering

*Healthcare Partner*
Purdue Veterinary Medicine Hospital

**Research Direction**

*Research Focus Area*
Emerging research interests

*Competencies*
Gesture recognition
Robotic control

*Research-to-Impact Phase*
Phase B (research and model development)

*Research Timeline*
2011–2014

**Project Summary**

*Healthcare Problem*
While surgeon–scrub nurse collaboration provides a fast, straightforward method of delivering surgical instruments to the surgeon, it often results in mistakes. These errors can have a negative impact on the outcome. These errors could potentially be reduced by introducing robotics into the operating room.

*Research Objectives*
Develop a robotic scrub nurse capable of handling and passing surgical instruments with accuracy.

*Methodology*
Gestonurse uses real-time hand tracking and recognition based on fingertip detection and gesture inference. It provides the following features: (a) ease of use, (b) natural interaction, (c) an unencumbered interface, and (d) reliability. The robot can pick instruments when they are as close as 25 mm apart.

*Potential Impact*
A robotic scrub nurse has the potential to reduce errors in the OR by automating the passing of surgical instruments which allows personnel to focus on more complicated tasks such as maintaining a sterile environment, preparing required surgical supplies and
monitoring the state of the patient. These failures can lead to wastage of resources, procedural errors, delays, distraction and inefficiency.

**Project Update**

The robotic scrub nurse has been transferred to two different robots to test robustness and usability. In both robots, speech, hand gestures, feet gestures, and voice recognition have been integrated. In the WAM, gaze recognition was also implemented with relative success. The Baxter's two arms allowed us to test operations such as holding (with suction) surgical towels and delivering those to the surgeon. An extension was to add haptic information to "acknowledge" the receipt of the surgical tool. Recently, the Baxter robot was featured at an event with Rodney Brooks and shown on the local TV news (5/8/14).
Project Summaries

Rating Healthcare

Research Team

Faculty
Ping H Huang, Regenstrief Center for Healthcare Engineering
Tzuong-tsieng Moh, Department of Mathematics

Research Direction

Research Focus Area
Emerging research interests

Competencies
Mathematical modeling

Research-to-Impact Phase
Phase B (research and model development)

Research Timeline

Project Summary

Healthcare Problem
The recent released results for Medicare’s accountable care experiment under the Patient Protection and Affordable Care Act underscore the uneven progress by hospitals and doctors trying to curb healthcare costs by coordinating treatment and reducing unnecessary care. CMS measured the quality of care using 33 measures. Many questioned that how the weights assigned to each measure might bias the quality score. On consumers’ side, patients face difficulties to choose among options when healthcare is needed. There are many criteria to consider: price for the procedure, doctor’s rating, hospital’s ranking, etc. There is no obvious winner.

Research Objectives
Apply emerging mathematical modeling techniques for multi-criteria ranking and assess effectiveness of these ranking methods in assisting in healthcare decision-making.

Methodology
This project uses multi-criteria, mathematical ranking algorithms

Potential Impact
This project aims to develop a rating algorithm that accounts for multiple criteria and non-linear relationships. The result could be hospital ranking results that are more meaningful, and the algorithm could contribute to future projects.

Project Update
We conducted literature reviews and concluded that our work is original. The currently available methods for multi-criteria analysis
are of various forms of the weighted scoring method. The popular logistic linear regression is one of them. Weighted ranking can help decision-making when there is no obvious winner. Each option is judged by a number of criteria; each criterion is assigned a weight which reflects its relative importance to other criteria; an overall score is calculated for each option, and then the options are ranked in descending order of their overall score. The top-scoring option is the best choice. Therefore, the appropriate weighting schemes become critical to the resulted rankings. Domain experts usually spend considerable amount of time to get consensus on the relative importance of the criteria. Here is an example for a hypothetical health services ranking and a group has decided that the following weights are appropriate: (1) number of cases treated – 40%; (2) waiting time = 30%; (3) patient access – 20%; (4) disruption to services – 10%. Nevertheless, other groups may feel that such a weight assignment is biased. The weighted scoring methods are currently used in college rankings, hospital rankings, consumer products ranking, and etc.

We want to find a method that is "bias-free". Google's PageRank algorithm assesses the importance of web pages without human evaluation of the content. In fact, Google feels that the value of its service is largely in its ability to provide unbiased results to search queries. We realize that Google's PageRank uses the hyperlink matrix while sports teams’ rankings use the game matrix. We developed (1) a matrix that accounts for all criteria involved in the ranking process and are developing (2) a method based on the classical mathematical results that will carry out the analysis quickly.

In the coming months, we will draft a manuscript for journal publication; we will also implement a healthcare related ranking project such as patients’ stratification that providers can use to help population health management.
Appendix C: Publications
Publications 2013–14

Refereed Publications


Jacob, M. G., & Wachs, J. P. (2014). Context-based hand gesture recognition for the operating room. Pattern Recognition Letters, 36(0), 196-203. doi: http://dx.doi.org/10.1016/j.patrec.2013.05.024


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**Non-Refereed Publications**


## Metrics 2013–18

<table>
<thead>
<tr>
<th>RCHE Metric (2013–18)</th>
<th>2013–14 Progress</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation President and Purdue President meet twice annually</td>
<td>Phone call: April 10, 2014</td>
</tr>
<tr>
<td>One to three seats on the Advisory Council</td>
<td>RCHE Advisory Council being reorganized this year. Internal council meeting: May 28, 2014</td>
</tr>
<tr>
<td>RCHE research with an objective of impact will include research, validation, and dissemination partners</td>
<td>See partners listed for each project, pages 32–91.</td>
</tr>
<tr>
<td>RCHE research conducted to achieve pre-impact objectives will involve research partners as is appropriate for the specific research.</td>
<td>See partners listed for each project, pages 32–91.</td>
</tr>
<tr>
<td>Research funding from major national funding sources awarding competitive grant applications</td>
<td>Grants this year from: National Science Foundation.</td>
</tr>
<tr>
<td>Publish research findings and reports in peer reviewed journals.</td>
<td>See Publications (page 95–98)</td>
</tr>
<tr>
<td>Conduct research in transdisciplinary teams</td>
<td>Ongoing. See researcher departments in Research Areas (page 15–25)</td>
</tr>
<tr>
<td>Research projects with impact objectives include active dissemination by one or more dissemination partners</td>
<td>See partners listed for each project, pages 32–91.</td>
</tr>
<tr>
<td>Partners will evaluate the center during the grant period</td>
<td>To be completed further into the period. Projected completion: Spring 2016.</td>
</tr>
<tr>
<td>Evaluate research findings for impact on healthcare delivery</td>
<td>To be completed further into the period. Projected completion: Spring 2016.</td>
</tr>
<tr>
<td>Help sustain HSEA</td>
<td>Ken Musselman serves on the board. RCHE maintains Hub infrastructure for dissemination.</td>
</tr>
<tr>
<td>Host at least one HSEA conference</td>
<td></td>
</tr>
<tr>
<td>At least three multi-university proposals</td>
<td>NSF ERC proposal submitted Fall 2013, with University of Wisconsin-Madison</td>
</tr>
<tr>
<td>Gap analysis/benchmarking against at least two other centers</td>
<td>To be completed further into the period. Targeted for 2015.</td>
</tr>
<tr>
<td>Evaluate effectiveness of research team in meeting objectives, dissemination success, and impact</td>
<td>To be completed further into the period. Projected completion: Spring 2016.</td>
</tr>
<tr>
<td>Host two conferences annually</td>
<td>IPI Virtual Conference: October 2013</td>
</tr>
<tr>
<td></td>
<td>IPI Conference: May 21-22, Indianapolis, IN</td>
</tr>
<tr>
<td>Host three nationally prominent speakers/year</td>
<td>Karl Gumpper, Bona Benjamin, Thomas Pogge</td>
</tr>
<tr>
<td>Assess healthcare delivery hub as an improvement and knowledge community tool</td>
<td>Integrated into IT development. See page 8.</td>
</tr>
<tr>
<td>Submit annual operating budget</td>
<td>Submitted in April 2014</td>
</tr>
<tr>
<td>Document management of foundation funds &amp; submit monthly financial report</td>
<td>Achieved.</td>
</tr>
</tbody>
</table>