Executive Summary

April 21, 2017

WIHSE Vision: WIHSE strives to be the premier research institute that transforms health care through engineering.
The Inaugural Conference for the Wisconsin Institute for Healthcare Systems Engineering (WIHSE) was held March 16 and 17, 2017 at the Wisconsin Institutes for Discovery. In attendance were 157 speakers, faculty, researchers and students from the University of Wisconsin-Madison, UW Health, stakeholder groups and industry. (See Appendix A) Keynote speakers included Carolyn Clancy, Deputy Under Secretary for Health for Organizational Excellence, Department of Veterans Affairs and Patricia Flatley Brennan, Director of the National Library of Medicine. Also joining as speakers were Judy Faulkner, founder and CEO of Epic (Verona, WI), and leaders from the Agency for Healthcare Research and Quality (AHRQ) – Jeffrey Brady, National Cancer Institute (NCI) – Bradford Hesse, National Patient Safety Foundation (NPSF) – Tejal Gandhi, UnitedHealth Group – Chuck Officer, National Academy of Medicine – Michael McGinnis, UW Health – Alan Kaplan and leaders from UW-Madison. (See agenda, including speakers – Appendix B; when viewing this summary electronically, links are provided to slides and the video recording of each speaker or panel.)

Conference Overview
The objective of the conference was to define the healthcare systems engineering (HSE) research agenda of the future for WIHSE. It followed two previous roundtables: an Engineering Roundtable held on August 29, 2016 and “When Health Care Meets Engineering” on January 12, 2017 (http://wihse.engr.wisc.edu/). At the first roundtable, faculty and research staff from the UW-Madison College of Engineering identified potential themes for HSE research, building on the “data rich information poor” state of health care in the US in conjunction with the “patient journey.” They proposed research that addresses “engineering novel healthcare systems to optimize workflow and management of information.” At the January 2017 roundtable, faculty and researchers from the health sciences and engineering further refined the research agenda by adding a clinical perspective. Thus, participants at the Inaugural Conference continued the process of defining and refining WIHSE’s research agenda.

Speakers for the Inaugural Conference were all asked to present the HSE challenges and needs faced by their domain and how they envisioned HSE research as making a significant contribution in addressing and resolving the needs and challenges. Full support of WIHSE’s endeavor was echoed by introductory remarks made by the deans (or their representatives) from the College of Engineering – Ian Robertson, Schools of Medicine and Public Health – Richard Moss, Nursing – Barbara Bowers and Pharmacy – Steven Swanson and the Associate Vice Chancellor for the Physical Sciences – Steve Ackerman. Also participating in the opening session was Judy Faulkner, CEO of Epic. She focused on the role of engineers at Epic in software development and technical support and how her organization meets and anticipates their customers’ needs. She emphasized that Epic is fully aware of and is addressing the need for shared data across users and increased user (i.e., provider) satisfaction/decreased user burnout.

Introductory keynote speaker Carolyn Clancy posed three challenges as she discussed the transformation that has occurred in the Veterans Health Administration:

1) How can we work together to make the right thing easy to do?
2) Improving safety and quality has come at a cost to clinicians and patients. How do we address these major concerns?
3) How do we address the Quadruple Aim?

Dr. Clancy attributed much of the success of the VA in overcoming their challenges to the partnerships created for and between patients and providers as well as its focus on high reliability. Dr. Clancy also gave examples of tools developed and being used at the VA to overcome issues of patient access, timeliness of care and technology design and use. Similarly, the VA intends to identify new approaches to emerging patient needs and expectations while encouraging clinician-patient engagement that includes open discussion of errors in diagnosis.
A discussion between Michael McGinnis and Alan Kaplan, facilitated by working group member Maureen Smith, focused on the “big picture” and an application for WIHSE at an organization level, respectively. Dr. McGinnis discussed the “chaos” of health care today, which begs for integration with engineering. He also pointed out the ever-increasing complexity and pace of “health care of tomorrow” and emphasized that such care must always promote a two-way exchange between the patient and provider. Dr. Kaplan emphasized the “five whys,” the need to address waste in health care and the value engineers add to improvements. He emphasized the importance of data when making decisions but also reminded the attendees that “behind statistics are real people.”

The Stakeholder panel, facilitated by working group member Beth Meyerand, comprised of representatives from AHRQ, NCI, UnitedHealth Group and NPSF.

AHRQ continues to emphasize the need for research – from bench to dissemination and implementation – and, to the extent possible, that produces measurable outcomes. Dr. Jeff Brady, Director, Center for Quality Improvement and Patient Safety, pointed to the successful joint effort between the Agency and CMS in decreasing healthcare-associated complications nation-wide. Priorities for AHRQ are: diagnostic error, patient safety outside the hospital setting, healthcare-associated infections, measurement systems, and patient-provider communication and engagement. Dr. Brady suggested that healthcare simulation is both under-utilized and under-appreciated – a challenge for engineers.

Dr. Brad Hesse, Chief, Health Communication and Informatics Research Branch at NCI, emphasized the need to address the Quadruple Aim. The cancer survivorship community of the future will continue to grow as will the “oldest of the old,” both of which will challenge healthcare system capacity. Dr. Hesse suggested that the three areas of research most needed include: 1) understanding and tapping the power of “connected health” to enhance teamwork, 2) identifying strategies for patient engagement, and 3) developing approaches for using data from connected technologies to enhance clinical care.

Chuck Officer, Vice President of Innovation at UnitedHealth Group, shared the priorities of his company’s culture: integrity, compassion, relationship, innovation and performance. As we aim to “fix” the healthcare system we must understand that, as a result, health care will be disrupted. We cannot “order” innovation but we can strive to create an environment conducive to innovation. The challenges associated with these goals include who will address the challenges and when and how will change evolve. Mr. Officer pointed out that practices such as self-care promote consumer engagement.

Dr. Gandhi, President and CEO of NPSF, discussed the importance of having a proactive focus on safety and the need to address the total system. She presented the goals that include advancing patient safety as a public health issue, establishing patient and workforce safety as a leadership core value and ensuring the workforce is skilled and capable in patient safety science. She emphasized that healthcare systems engineering is critical to solving the issues health care faces. In concert with the four WIHSE research “themes,” Dr. Gandhi proposed:

1. **Monitoring and anticipating safe care transitions for vulnerable populations** – significant tools and technologies are need to manage handoffs, medication reconciliation, test result management, patient education and follow-up planning.
2. **Smart automation and technologies for coordination and communicating diagnosis and treatment** – needed are test result and referral management systems, algorithms and natural language processing for diagnostic reasoning, identifying patients at risk of misdiagnosis, useful decision support, and teamwork and communication for complex treatment plans.
3. **Smart and connected patient-centered care** – engineering can ensure patient portals, apps, devices and sensors are optimized for all kinds of patients and caregivers, and pursue tools for shared decision making and patient engagement.
4. Patient safety: Modeling, forecasting responding to healthcare-associated complications – this requires ties to measurement, that algorithms are proactive rather than reactive and decision support is appropriately designed and applied.

Two and one-half hours of Thursday conference time was spent with attendees convening into small groups to develop potential research ideas for WIHSE. The ideas focused on seven combined engineering and clinical domains including:

1) Monitoring and anticipating safe care transitions for pediatric patients
2) Monitoring and anticipating safe care transitions for elderly patients
3) Smart automation and technologies for coordinating and communicating diagnosis and treatment of cancer
4) Smart automation and technologies for coordinating and communicating diagnosis and treatment of diabetes
5) Smart and connected patient-centered care: Implications for clinical decision support, telehealth and sensing technologies
6) Patient safety: Modeling, forecasting and responding to healthcare-associated infections
7) Patient safety: Modeling, forecasting and responding to medication errors.

Each of the 16 small groups was asked, after an initial brainstorming session, to propose a research project that included: a title, specific aims/objectives, collaborators and potential stakeholders (funding sources). Their results are provided in Appendix C.

The Collaboration Panel, facilitated by Dan Thoma, Director of the Grainger Institute for Engineering, was comprised of engineers who “paired” with physicians or nurses on specific research projects. Pairs (with the engineer listed first) included: Peter Hoonakker (CQPI) and Michelle Kelly (Pediatrics), Jingshan Li (ISyE) and Al Musa (Dean/SSM Health System), Beth Meyerand (BME) and Vivek Prabhakaran (Radiology), Linsey Steege (Nursing) and Barbara King (Nursing), Nicole Werner (ISyE) and Manish Shah (Emergency Medicine), and Douglas Wiegmann (ISyE) and Caprice Greenberg (Surgery). The primary focus was on the “next big idea” for health care and engineers to address. Below is a summary of the discussion between the conference participants and the panelists.
The closing keynote speaker, former UW-Madison Professor of Nursing and Industrial and Systems Engineering Patti Brennan, now Director of the National Library of Medicine, emphasized the need for “thoughtful solutions” to the challenges we face, with an emphasis on data. Fundamental to NLM is data science and data discovery, both of which are pushing the demands for effective use of data for discovery. In response to this, engineering can provide models that ensure technical and thoughtful solutions to data management. Challenges of today that require an expanded understanding of data and its use include team science, globalization and open science. Yet, all of the associated data we use and rely on must be findable, accessible, interoperable and re-usable. Dr. Brennan suggested that engineers can respond to these challenges with: 1) data-driven and data-producing innovations, 2) advanced analytics and 3) accelerated interpretations with less reliance on visualization.

Poster Session
Graduate students and researchers were given the opportunity to present their research. At the end of the day on Thursday, March 16, twenty-four posters were available for participants to review and then pose questions to students and researchers. Posters represented collaborations between COE faculty and research staff (i.e., BME, ECE, ISyE, ME, MSE, CQPI, CHESS, CHSRA), the Schools of Medicine & Public Health, Nursing and Pharmacy, UW Health, American Family Children’s Hospital, William S. Middleton Memorial VA Hospital, WID, the Morgridge Institute for Research, WREN, UW Carbone Cancer Center and UW Schools of Business, Education and Library & Information Studies. (See Appendix D)

Evaluation Results
Sixty-three attendees completed an online evaluation distributed two days after the conference, and weekly for the next two weeks. Results are positive for all of the speakers, panels and the small group sessions. Suggestions for continued effort included the need to 1) continue to offer venues for discussion between engineering and the health sciences, 2) build opportunities for collaborative research, 3)
understand more of what is going on in this area across campus, 4) expand ways in which networking in this area can occur; and 5) identify funding sources. Detailed results are listed in Appendix E.
Appendices

Appendix A – Summary of WIHSE Inaugural Conference Attendees
Appendix B – WIHSE Inaugural Conference Agenda
Appendix C – Small Group Research Proposals
Appendix D – WIHSE Inaugural Conference Poster Presentations
Appendix E – WIHSE Inaugural Conference Evaluation Results
## Summary of WIHSE Inaugural Conference Attendees

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Appendix B

WIHSE Inaugural Conference Agenda

Objective: To define the healthcare systems engineering research agenda of the future.

Thursday, March 16, 2017

7:00 – 8:00 AM: Registration and Breakfast

8:00 – 9:00 AM: Welcome: Introduction to WIHSE and the Inaugural Conference [presentation video]

- Pascale Carayon, Procter & Gamble Bascom Professor in Total Quality, Department of Industrial and Systems Engineering, UW-Madison [slides]
- Judy Faulkner, Founder and CEO, Epic
- Ian Robertson, Dean, College of Engineering, UW-Madison
- Barbara Bowers, Associate Dean for Research, Charlotte Jane and Ralph A. Rodefer Chair, Helen Denne Schulte Professor, School of Nursing, UW-Madison
- Richard Moss, Senior Associate Dean for Basic Research, Biotechnology and Graduate Studies, School of Medicine and Public Health, UW-Madison
- Steve Swanson, Dean, School of Pharmacy, UW-Madison
- Steve Ackerman, Associate Vice Chancellor for Physical Sciences, UW-Madison

9:00 – 10:00 AM: Keynote Address

- Carolyn Clancy, Deputy Under Secretary for Health for Organizational Excellence, Department of Veterans Affairs [slides] [presentation video]

10:00 – 10:30 AM: Break

10:30 AM – 12:00 PM: Small Group Discussion about WIHSE Research Themes

- Monitoring and anticipating safe care transitions for pediatric patients
- Monitoring and anticipating safe care transitions for elderly patients
- Smart automation and technologies for coordinating and communicating diagnosis and treatment of cancer
- Smart automation and technologies for coordinating and communicating diagnosis and treatment of diabetes
- Smart and connected patient-centered care: Implications for clinical decision support, telehealth and sensing technologies
- Patient safety: Modeling, forecasting and responding to healthcare-associated infections
- Patient safety: Modeling, forecasting and responding to medication errors

12:00 – 1:00 PM: Lunch

1:00 – 2:00 PM: Perspectives from Healthcare Delivery [presentation video]

Facilitator: Maureen Smith, Professor, Departments of Population Health Sciences and Family Medicine, UW-Madison
- Michael McGinnis, Leonard D. Schaeffer Executive Officer, National Academy of Medicine
- Alan Kaplan, CEO, UW Health
2:00 – 2:15 PM: Break

2:15 – 3:45 PM: Perspectives from Stakeholders [presentation video]
   Facilitator: M. Elizabeth Meyerand, Professor, Department of Biomedical Engineering, UW-Madison
   • Jeff Brady, Director, Center for Quality Improvement and Patient Safety, Agency for Healthcare Research and Quality [slides]
   • Bradford Hesse, Chief, Health Communication and Informatics Research Branch, National Cancer Institute [slides]
   • Chuck Officer, Vice President of Innovation, UnitedHealth Group [slides]
   • Tejal Gandhi, President and CEO, National Patient Safety Foundation [slides]

3:45 – 4:45 PM: Small Group Sessions
   • Follow-up from morning sessions

4:45 – 5:00 PM: Wrap-up of the Day
   • Pascale Carayon

5:00 – 6:30 PM: Evening Reception and Poster Session

Friday, March 17, 2017

7:30 – 8:30 AM: Breakfast; Optional Continuation of Small Group Discussions

8:30 – 8:35 AM: Welcome and Overview of the Morning
   • Pascale Carayon

8:35 – 10:15 AM: Perspectives on Interdisciplinary Collaboration [slides] [presentation video]
   Facilitator: Dan Thoma, Director, Grainger Institute for Engineering, UW-Madison
   • Peter Hoonakker, Research Scientist and Associate Director for Research, Center for Quality and Productivity Improvement, UW-Madison & Michelle Kelly, Assistant Professor, Department of Pediatrics, UW-Madison
   • Jingshan Li, Professor, Department of Industrial and Systems Engineering, UW-Madison & Al Musa, Physician and Board Chair, Dean Medical Group
   • M. Elizabeth Meyerand, Professor, Department of Biomedical Engineering, UW-Madison & Vivek Prabhakaran, Assistant Professor, Department of Radiology, UW-Madison
   • Linsey Steege, Assistant Professor, School of Nursing, UW-Madison & Barbara King, Assistant Professor, School of Nursing, UW-Madison
   • Nicole Werner, Assistant Professor, Department of Industrial and Systems Engineering, UW-Madison & Manish Shah, Associate Professor, Department of Emergency Medicine, UW-Madison
   • Douglas Wiegmann, Associate Professor, Department of Industrial and Systems Engineering, UW-Madison & Caprice Greenberg, Professor, Department of Surgery, UW-Madison

10:15 – 10:45 AM: Break

10:45 – 11:45 AM: Keynote Speaker
   • Patricia Flatley Brennan, Director, National Library of Medicine [slides] [presentation video]

11:45 AM – 12:00 PM: Wrap-up, Next Steps and Thank You
   • Pascale Carayon
Appendix C

Small Group Research Proposals

Utilizing a universal risk profile for pediatric patients to achieve safe transitions

Objectives/specific aims:
1.) Create a universal triage, transfer and treatment system of care across all providers.
2.) Provide seamless transitions from the patient/family perspective.
3.) Create a virtual patient navigator that is accessible to all providers and the family.
4.) Leverage technology (e.g. smart phones and social media) to monitor and transfer information to providers.

**Topic Area:** Monitoring and anticipating safe care transitions for pediatric patients

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Utilizing a universal risk profile for pediatric patients to achieve safe transitions, cont’d.

• Potential collaborators:
  Predictive modeling people (healthcare space), families, healthcare providers, different types of hospitals (testbeds), payors, healthcare IT people, systems designers

• Stakeholder group to which project would be proposed:
  Solutions for Patient Safety Network, large healthcare networks (urban and rural), patient safety advocacy groups, celebrity advocates

• Small group participants:
  Tom Brazelton, Sue Gaard, Beth Meyerand, Stephen Muething, Anne Thurber, Maureen Walz
Experiences and outcomes of home-based care for children with new respiratory technology

Objectives/specific aims:
1.) Identify barriers and facilitators to the use of technology to support care of pediatric patients and families in the home (i.e. vents, BiPAP/CPAP, oxygen) – using the SEIPS model.
2.) Assess caregivers’ acceptance of technology.
3.) Assess caregivers’ satisfaction with discharge transition.
4.) Conduct interviews with caregivers, home support staff and other outpatient professionals who collaborate with the discharge process.

**Topic Area:** Monitoring and anticipating safe care transitions for pediatric patients

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Experiences and outcomes of home-based care for children with new respiratory technology, cont’d.

- Potential collaborators:
  Ryan Coller, Milwaukee Children’s Hospital, Anne Thurber, UCLA, Nicole Werner
- Stakeholder group to which project would be proposed:
  AHRQ, HRSA, NHLBI, NINR, Optum, PFAC
- Small group participants:
  Ryan Coller, Peter Hoonakker, Michelle Kelly, Jonathan Kohler, Amanda Ramer, Mary Umbeck
Creating interconnected communities to improve transition safety for older adults

-or-

Transforming information into action: Designing safe, smart and integrated total care

Objectives/specific aims:
1.) Describe support structures and identify barriers and facilitators to integrated care.
   a. Identify and activate community support structure.
2.) Identify community pathways/touch points.
3.) Use in-home system monitoring to predict failures and communicate them before the failure can occur.
   a. Integrate Pt. goals b. “Circle of support”

*Topic Area: Designing safe care transitions for older adults*

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Creating interconnected communities to improve transition safety for older adults

-or-

Transforming information into action: Designing safe, smart and integrated total care, cont’d.

• Potential collaborators:
Community pharmacy, community agencies, interconnected community: paramedics, healthcare systems/services, insurance providers, families/neighbors, community organizations, religious organizations

• Stakeholder group to which project would be proposed:
AHRQ, NIA, NSF (Smart & Connected Health)

• Small group participants:
David Hager, Angela Ingraham, Amy Kind, Barb King, Kevin Look, Todd Molfenter, Edmond Ramly, Nicole Werner
Designing a decision support system for facilitating goal-congruent care

Objectives/specific aims:

1.) Identify design requirements for clinician signals about treatments/prognosis/trade offs.
2.) Identify design requirements for translating decisions between clinicians and patients that attend to patient goals.
   a. Smart technology for dynamic updates
3.) Develop decision support system that coordinates the clinical course with treatments and strategies that match the patient’s goals.

**Topic Area:** Smart automation and technologies for coordinating and communicating diagnosis and treatment of cancer

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Designing a decision support system for facilitating goal-congruent care, cont’d.

- **Potential collaborators:**
  Researchers/clinicians in: shared decision making, patient satisfaction, clinical decision support, data mining/computational algorithms, data visualization, teamwork and communication
- **Stakeholder group to which project would be proposed:**
  AARP/National, AHRQ, AMA/Society of Medicine, ASCO/NCCN/NCI/ICTR, Decision Making/ACS, Fed. Reserve., NCI, NIH, Partner Women, PCORI
- **Small group participants:**
  Tim Bartholow, Eric DuBois, Gretchen Schwarze, Doug Wiegmann, Susan Wiegmann, Soovin Yoon
Coordinated Augmented Response Ecosystem (C.A.R.E)

Objectives/specific aims:

Research Question: What is the system intervention needed to coordinate communication and ongoing care during the first month post diagnosis of colon cancer?

1.) Conduct needs assessment through:
   a. Information needs identification
   b. Quantifiable outcomes of interest to stakeholders (esp. patients)
   c. Human-system integration
   d. Systems analysis

2.) Perform prototype assessment that includes:
   a. Dynamic dashboard – updated in real time, providing shared access to system status (e.g. radiology report)
   b. Holistic view of patient’s goals, needs and progress
   c. Patient-generated data

3.) Create iterative design, perform testing, and deploy tool via fit-for-purpose trials with actionable results.

*Topic Area:* Smart automation and technologies for coordinating and communicating diagnosis and treatment of cancer

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Coordinated Augmented Response Ecosystem (C.A.R.E), cont’d.

- Potential collaborators:
  Patients, caregivers/family, payers, informaticians, librarians, information science, statisticians, clinicians (oncology & primary care providers), administrators, navigators/social workers, community groups; logistic purposes: consultants and graphic designers

- Stakeholder group to which project would be proposed:
  Payers/insurers, advocacy groups, hospital administration, funders (e.g., NCI, ASCO)

- Small group participants:
  Anne Buffington, Lisa Cadmus-Bertram, Jeffrey Czebotar, Brad Hesse, Betsy Rolland, Amye Tevaarwerk
Towards a data singularity for diabetes prevention and control

Objectives/specific aims:

1.) Promote engagement and utilization of data from real-time remote sensing of diabetes to improve health outcomes.
2.) Use predictive analysis from disparate data sources to individualize interventions to improve health outcomes.
3.) Effectively synthesize and visualize data to improve patient engagement in their own health care.

Topic Area: Smart automation and technologies for coordinating and communicating diagnosis and treatment of diabetes

Towards a data singularity for diabetes prevention and control, cont’d.

• Potential collaborators:
  WIHSE, behavioral psychologists, health systems (e.g., pharmacists, diabetes educator, nurses, physicians), computer science
• Stakeholder group to which project would be proposed:
  Patient advocacy groups/patients, clinic teams, payer/insurers, epidemiologists, medical device vendors, EHR systems
• Small group participants:
  Gail Casper, Larry Hanrahan, Amanda Hoffmann, Marlon Mundt, Paul Reber, Maureen Smith, Xudong Wang
Promoting entourage-centered healthcare through virtual reality/augmented reality technology

Objectives/specific aims:
Utilize VR/AR and popular entertainment/consumer technologies to drive engagement and ownership in personal health care by patients and families.

1.) Identify scenarios that might be most impacted by multiple choices for patients and their entourage for a specific condition (e.g. metabolic syndrome).
2.) Understand assets and needs of various patients and their entourage to compile a library of potential health outcomes – where technology can help decision making.
3.) Develop VR/AR scenarios that might be impacted by patients and their entourage’s assets and needs.
4.) Test the impact of this VR/AR scenario on a pilot group of patients and their entourage.

Topic Area: Smart and connected patient-centered care: Implications for clinical decision support, telehealth and sensing technologies

Promoting entourage-centered healthcare through virtual reality/augmented reality technology, cont’d.

• Potential collaborators:
  Hollywood/theater, artificial simulation developers, process specialists, government agencies, patient advocacy, social workers, gaming/game testers, health literacy specialists

• Stakeholder group to which project would be proposed:
  VR companies, Google, Hospitals, insurance industries, healthcare systems, government agencies, major foundations

• Small group participants:
  Dennis Barnum, Mark Boardman, David Gustafson, Bryan Kim, Kelly Landsman, Regina Vidaver
Patient-centered information sharing for improved collaborative decision making

Objectives/specific aims:

1.) Understand data, synthesized appropriately, can be useful.
   a. Sensing (numeric) and qualitative feedback

2.) Determine if feedback/inclusion of patients in process increases interactivity.

3.) Ensure patient activation, providing feedback loop.
   a. Matching clinical goals to personal life

Null hypothesis: Improved collaboration and decision making $\rightarrow$ better patient outcomes and higher value

**Topic Area:** Smart and connected patient-centered care: Implications for clinical decision support, telehealth and sensing technologies

Patient-centered information sharing for improved collaborative decision making, cont’d.

- Potential collaborators:
  Instrumentation engineers, sensory technologists (e.g. noninvasive real-time glucose measurement), cognitive engineers (designing to environment to promote positive habits), data visualizers, EHR/EMR developers, providers, patients, behavioral scientists, data scientists

- Stakeholder group to which project would be proposed:
  Disease-specific voluntary health group, PCORI, NIBIB, AHRQ, NSF

- Small group participants:
  Mitchel Keogh, Hans Kuttner, John Lee, Jeff Linderoth, Al Musa, Jessica Rainbow, Adhira Sunkara
“M-Health” system for patient and provider engagement in chronic pain management to facilitate safe opioid use: A patient-level RCT

Objectives/specific aims:
1.) Balance pain, opioid dose and quality of life (physical, emotional and social).
2.) Promote patient engagement and personalized goal setting.
3.) Provide remote care.
   a. Adjust intervals for “in-person” appointments
   b. Facilitate personalized care (remote and in-person)
4.) Conduct statistical analysis of:
   a. Performance
   b. Goal adjustment
   c. Factors impacting outcomes
   d. Optimize delegation of responsibilities

Topic Area: Smart and connected patient-centered care: Implications for clinical decision support, telehealth and sensing technologies

“M-Health” system for patient and provider engagement in chronic pain management to facilitate safe opioid use: A patient-level RCT, cont’d.

• Potential collaborators:
  Patient (with both pain and opioid use), support system (individual, family, neighbor, friend), health care providers (physician, pharmacist, nurse, social worker), community partners, healthcare systems, policy agencies, community-advisory groups, Others: IT, statisticians, engineers, EHR vendor, mobile providers

• Stakeholder group to which project would be proposed:
  Payors (HMOs, Medicaid, Medicare, Public Health, uninsured), grant funders, potential sites, providers (healthcare organizations)

• Small group participants:
  Sarah Brzozowski, Sarah Kruger, Adel Nasiri, Andrew Quanbeck
Use cases for advancing connected care for improving patient and clinician experience

Objectives/specific aims:
1.) Overcome trust barriers to implementation of new technologies.
2.) Collect patient data seamlessly.
3.) Overcome policy and operational barriers to implementation.
4.) Identify applications for which the benefits significantly exceed risks.
5.) Provide feedback for patient care.
6.) Enhance customization of workflows (by individuals).
7.) Center data on patients/patient control of data assets.

Topic Area: Smart and connected patient-centered care: Implications for clinical decision support, telehealth and sensing technologies

Use cases for advancing connected care for improving patient and clinician experience, cont’d.

- Potential collaborators:
  VA, UW Health, patients, large HER vendors, smaller technology firms/device companies, physicians, engineers, ONC

- Stakeholder group to which project would be proposed:
  none listed

- Small group participants:
  Laura Albert-McLay, Brian Patterson, Chuck Officer, Margo Reeder, Gabriel Zayas-Caban
Continuous Adaptable Standalone Patient Recovery System (C.A.S.P.R.S.) [“smart bed”]

Objectives/specific aims:
1.) Create a self-contained smart bed that can support additional plug-and-play sensory equipment via a universal standard that is:
   a.) Modular
   b.) Supports and powers at least 12 sensors simultaneously
   c.) Meets all regulatory requirements
   c.) Able to wirelessly transmit data to central IT solution

BONUS Objectives:
Is self-driving and wirelessly powered
Can be moved from hospital to home with sensors
Capable of closed-loop control with sensors (automatic bed intervention)

Topic Area: Monitoring and anticipating safe care transitions for pediatric patients

Continuous Adaptable Standalone Patient Recovery System (C.A.S.P.R.S.) [“smart bed”], cont’d.

• Potential collaborators:
  Industrial engineers, electrical/computer engineers, mechanical engineers, nurses and physicians, architects (for movement through buildings)

• Stakeholder group to which project would be proposed:
  Bed manufacturers, home care, CMS, patient safety, insurance companies, Cerner/Epic, NIA, NINR, NSF

• Small group participants:
  Amy Cochran, Aaron Kaplan, Katharyn May
Predictive Analytics from Concept 2 Execution (PAC2E)

Objectives/specific aims:
1.) Identify barriers to implementation.
   a. GAP analysis of current to true/state what exists
2.) Develop infrastructure.
3.) Develop toolkit/readiness checklist.
4.) Apply toolkit to pilot existing model and new model.
   a. Readmission
   b. Sepsis
   c. Hospital-acquired/associated infections
5.) Use models of innovation/adoptions/diffusion.
6.) Identify mechanism for interactive refinement/improvement of models.

*Topic Area: Smart and connected patient-centered care: Implications for clinical decision support, telehealth and sensing technologies*

Predictive Analytics from Concept 2 Execution (PAC2E), cont’d.

- Potential collaborators:
  UW Health, Epic, nursing, medicine, engineering, AHRQ, WARF, IT, legal
- Stakeholder group to which project would be proposed:
  AHRQ, TBD, ICTR
- Small group participants:
  Jeff Brady, Abram Becker, Shannon Dean, Peggy Hatfield, Barbara Pinekenstein,
  Timothy Thompson
Real time prediction, detection, and action to reduce healthcare-associated infections

Objectives/specific aims:
Within the context of an integrated system:
1.) Develop tools to accurately predict patients at high risk for HAI and prevent HAIs from developing.
2.) Develop and implement real time ("early") detection tools and methods to screen for HAIs.
3.) Develop feedback system that is intuitive and user-centered.
4.) Develop strong patient/caregiver/provider partnership and integration to empower patients and caregivers.

**Topic Area:** Patient safety: Modeling forecasting and responding to healthcare-associated infections

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Real time prediction, detection, and action to reduce healthcare-associated infections, cont’d.

- Potential collaborators:
  Infectious disease, analytics, informatics, patient representatives, systems engineers, microbiology, clinicians, patient/caregiver, sensors (Electrical/Computer Engineering), pharmacy, central supply, housekeeping
- Stakeholder group to which project would be proposed:
  AHRQ, healthcare organization (e.g. UW Health), SMPH, ICTR, foundations, NIH, PCORI
- Small group participants:
  Nicole Domask, Ann Hundt, Leon Janssen, Nizar Jarjour, Tonya Roberts
Development of predictive (timing, risk factors) modeling of healthcare-associated infections for translating into practice

Objectives/specific aims:
1.) Develop predictive model of HAI (timing of HAI, risk factors and risk escalation).
   a. Include/start with a qualitative study to build the model
2.) Test and validate in an actual healthcare setting.
3.) Translation-to-practice
   a. Design must be usable and sustainable
   b. Identify ways culture influences bi-directionally

*Topic Area*: Patient safety: Modeling forecasting and responding to healthcare associated infections

Development of predictive (timing, risk factors) modeling of healthcare-associated infections for translating into practice, cont’d.

- Potential collaborators:
  ISyE (analytics skills, human factors skills), infection control, nurses/physicians/pharmacists, visional leader, patient advocates
- Stakeholder group to which project would be proposed:
  RWJ, health systems, federal agencies
- Small group participants:
  Oguz Alagoz, Elise Knudsen, Megan Netzel, Barbara Rudolph, Amy Topel
Reducing adverse drug events (ADE) during operating room transitions in a pediatric acute care setting

Objectives/specific aims:
1.) Identify prevalence and severity of ADEs.
2.) Describe identifying factors.
3.) Develop a testable intervention.
4.) Evaluate the effectiveness and implementation of the intervention, including unintended consequences.

**Topic Area:** Patient safety: Modeling forecasting and responding to medication errors

Reducing adverse drug events (ADE) during operating room transitions in a pediatric acute care setting, cont’d.

- Potential collaborators:
  Stakeholders – AFCH administration, pediatrics, anesthesiology, surgery, nursing, pharmacy, HSE

- Stakeholder group to which project would be proposed:
  AFCH administration, Children’s Hospital of Wisconsin, ADE Healthcare Advisory group (Solutions for Patient Safety collaborative)

- Small group participants:
  Michelle Chui, Doug Coursin, Lori Haack, Jamie Stone
Integrated decision support to prevent medication error in fast-paced clinical scenarios – ED/OR/ICU

Objectives/specific aims:
1.) Identify and improve presentation of critical clinical information to support situation awareness and decision making.
2.) Reduce medication errors through monitoring, checking, alarming of errors.
3.) Integrate decision support with human factors and ergonomics.

*Topic Area: Patient safety: Modeling forecasting and responding to healthcare associated infections*

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Integrated decision support to prevent medication error in fast-paced clinical scenarios – ED/OR/ICU, cont’d.

- Potential collaborators:
  Anesthesiology, pharmacy, human factors/ergonomics, information technology, equipment vendors, clinical engineering, information science (e.g., data science visualization), surgery, nursing

- Stakeholder group to which project would be proposed:
  Hospitals, equipment manufacturers, software vendors

- Small group participants:
  Aaron Hess, Betsy Hose, Corey Lester, Jingshan Li, Stephen Robinson, Linsey Steege
Appendix D

WIHSE Inaugural Conference Poster Presentations

Neuronal micro-culture engineering using negative DEP
Authors: Hyungsoo Kim¹, Karl Richters², Jae Ha Ryu¹, Inkyu Lee¹, Jihye Bong¹, Joseph Novello¹, Yehee Hwan Jung¹, Erik Dent², Justin C Williams³, Zhenqiang Ma¹
Affiliation: ¹Department of Electrical and Computer Engineering, University of Wisconsin-Madison, ²Department of Neuroscience, University of Wisconsin-Madison, ³Department of Biomedical Engineering, University of Wisconsin-Madison

Role Network Analysis of Team Interactions and Individual Activities: Application of VTE Diagnosis Management
Authors: Yudi Wang², Pascale Carayon¹,², Shashank Ravi³, Ann Schools Hundt¹, Douglas Wiegmann², Brian Patterson³, Peter Hoonakker¹, Emily Wirkus¹
Affiliation: ¹Center for Quality and Productivity Improvement, University of Wisconsin-Madison, ²Department of Industrial and Systems Engineering, University of Wisconsin-Madison, ³Department of Emergency Medicine, University of Wisconsin School of Medicine and Public Health

Developing a Staff-Driven Electronic Tobacco Cessation Referral Program
Authors: Daniel Panyard¹, Edmond Ramly², Andrea Gilmore-Bykovsky³, Diane Lauver³, Robert Adsit⁴, Courtney Maxcy⁵, Christie M. Bartels¹.
Affiliations: ¹University of Wisconsin School of Medicine and Public Health, ²University of Wisconsin-Madison College of Engineering, ³University of Wisconsin-Madison School of Nursing, ⁴University of Wisconsin Center for Tobacco Research and Intervention, ⁵University of Wisconsin

The Hands and Head of a Surgeon: Modeling Operative Competency with Multimodal Epistemic Network Analysis
Authors: Andrew R. Ruis¹,², Alexandra A. Rosser², Cheyenne Quandt-Walle², Jay N. Nathwani¹, David Williamson Shaffer², Carla M. Pugh¹
Affiliations: ¹Department of Surgery, University of Wisconsin-Madison, ²Department of Educational Psychology, University of Wisconsin-Madison

Implantable Nanogenerators for In Vivo Biomedical Energy Harvesting
Authors: Jun Li¹, Yanhao Yu¹, Xudong Wang¹
Affiliations: ¹Department of Materials Science and Engineering, University of Wisconsin-Madison

Multifunctional Drug/Agent Nanocarriers for Various Biomedical Applications
Authors: Guojun Chen¹,², Yuyuan Wang¹,², Ruosen Xie¹,², and Shaoqin Gong¹,²,³
Affiliation: ¹Department of Materials Science and Engineering, University of Wisconsin-Madison, ²Wisconsin Institute for Discovery, University of Wisconsin-Madison, ³Department of Biomedical Engineering, University of Wisconsin-Madison

Understanding Team Complexity in Pediatric Trauma Care
Authors: Abigail Wooldridge¹, Pascale Carayon¹, Peter Hoonakker¹, Bat-Zion Hose¹, Joshua Ross², Jonathan Kohler², Tom Brazelton², Ben Eithun², Michelle Kelly², Shannon Dean², Deborah Rusy², Ayse Gurses³
Affiliations: ¹Center for Quality and Productivity Improvement, University of Wisconsin-Madison, ²Department of Industrial and Systems Engineering, University of Wisconsin-Madison, ³Department of Emergency Medicine, University of Wisconsin School of Medicine and Public Health

An Expected Coverage Model With A Cutoff Priority Queue
Authors: Soovin Yoon¹, Laura Albert McLay¹
Affiliation: ¹Department of Industrial and Systems Engineering, University of Wisconsin-Madison
High-performance flexible and stretchable electronics
Authors: Yei Hwan Jung, Juhwan Lee, and Zhenqiang Ma
Affiliation: \textsuperscript{1}Department of Electrical and Computer Engineering, University of Wisconsin-Madison

Application of Cognitive Work Analysis to Promote Patient Mobility as an ICU Quality Improvement Project
Authors: Anna Krupp, Barbara King, Linsey Steege, and Heather Royer
Affiliations: \textsuperscript{1}University of Wisconsin-Madison School of Nursing, \textsuperscript{2}William S. Middleton Memorial Veterans Hospital

Modeling, Analysis, and Improvement of Healthcare Delivery Systems
Authors: Hyo Kyung Lee, Sujee Lee, and Jingshan Li
Affiliation: \textsuperscript{1}Department of Industrial and Systems Engineering, University of Wisconsin-Madison

A 360 Degree View of Nurse Fatigue, and Current Monitoring and Management Strategies
Authors: Jessica G. Dykstra, Linsey M. Steege, and Barbara Pinekenstein
Affiliations: \textsuperscript{1}University of Wisconsin-Madison School of Nursing, \textsuperscript{2}Department of Industrial and Systems Engineering, University of Wisconsin-Madison

Information Needs of Physicians in Pediatric Trauma
Authors: Bat-Zion Hose, Pascale Carayon, Peter Hoonakker, Abigail Wooldridge, Joshua Ross, Jonathan Kohler, Tom Brazelton, Ben Eithun, Michelle Kelly, Shannon Dean, Deborah Rusy, Ayes Gurses
Affiliations: \textsuperscript{1}Department of Industrial and Systems Engineering, University of Wisconsin-Madison, \textsuperscript{2}Center for Quality and Productivity Improvement, University of Wisconsin-Madison, \textsuperscript{3}American Family Children’s Hospital at the University of Wisconsin Hospitals and Clinics, \textsuperscript{4}The Armstrong Institute for Patient Safety and Quality at Johns Hopkins University

Perceptions of Healthcare Workers Regarding the Patient Role in Daily Chlorhexidine Bathing
Authors: Karly R. Christensen, Ann Schoofs Hundt, Pascale Carayon, Michelle Zimbrick, Jackson Muusuza, Mel Reppen, Valerie Scheutz, Nasia Safdar
Affiliations: \textsuperscript{1}Department of Population Health Sciences, University of Wisconsin School of Medicine and Public Health, \textsuperscript{2}Center for Quality and Productivity Improvement, University of Wisconsin-Madison, \textsuperscript{3}Department of Industrial and Systems Engineering, University of Wisconsin-Madison, \textsuperscript{4}Division of Infectious Disease, Department of Medicine, University of Wisconsin School of Medicine and Public Health, \textsuperscript{5}William S. Middleton Memorial Veterans Affairs Hospital, Madison, WI, \textsuperscript{6}SSM Health, St. Mary’s Hospital, Madison, WI

Shared Situation Awareness in Primary Care Teams: Implications for EHR Design
Authors: Laura Farrell, Shimeng Du, Linsey M. Steege, Randi S. Cartmill, Douglas A. Wiegmann, Amanda E. Hoffmann, Mica R. Endsley, Tosha B. Wetterneck
Affiliations: \textsuperscript{1}Department of Industrial and Systems Engineering, University of Wisconsin-Madison, \textsuperscript{2}University of Wisconsin-Madison School of Nursing, \textsuperscript{3}University of Wisconsin School of Medicine and Public Health, \textsuperscript{4}Wisconsin Research and Education Network (WREN), \textsuperscript{5}SA Technologies

Improved Follow-Up of Hypertension in Rheumatology Patients: Results of a protocol intervention
Authors: Christie Bartels, Edmond Ramly, Heather Johnson, Yingqi Zhao, Zhanhai Li, Patrick McBride, Kristin Stephen Lewicki, Diane Lauver
Affiliations: \textsuperscript{1}Department of Medicine, Rheumatology Division, University of Wisconsin-Madison, \textsuperscript{2}Center for Health Systems Research and Analysis, College of Engineering, University of Wisconsin-Madison, \textsuperscript{3}Department of Medicine, Cardiovascular Division, University of Wisconsin-Madison, \textsuperscript{4}Department of Biostatistics, Fred Hutchinson Research Center, Seattle, WA, \textsuperscript{5}Department of Biostatistics, University of Wisconsin-Madison, \textsuperscript{6}Department of Family Medicine and Community Health, University of Wisconsin-Madison, \textsuperscript{7}Department of Medicine, General Internal Medicine Division, University of Wisconsin-Madison, \textsuperscript{8}School of Nursing, University of Wisconsin-Madison
Feasibility of a Rheumatology Staff Protocol for Tobacco Cessation Counseling and Quit Line Electronic Referral
Authors: Christie Bartels1, Daniel Panyard9, Diane Lauver7, Emmanuel Sampene4, Zhanhai Li4, Robert Adsit9, Patrick McBride3,5, Heather Johnson3, Kristin Lewicki6, Edmond Ramly2
Affiliations: 1Department of Medicine, Rheumatology Division, University of Wisconsin-Madison, 2Center for Health Systems Research and Analysis, College of Engineering, University of Wisconsin-Madison, 3Department of Medicine, Cardiovascular Division, University of Wisconsin-Madison, 4Department of Biostatistics, University of Wisconsin-Madison, 5Department of Family Medicine and Community Health, University of Wisconsin-Madison, 6Department of Medicine, General Internal Medicine Division, University of Wisconsin-Madison, 7School of Nursing, University of Wisconsin-Madison, 8Department of Population Health Sciences, University of Wisconsin-Madison, 9Center for Tobacco Research and Intervention, University of Wisconsin-Madison

Inter-Organizational Collaboration to Implement an Evidence-Based Tobacco Cessation Protocol for Cardiovascular Disease Prevention Specialty Clinics
Authors: Edmond Ramly2, Daniel Panyard3, Christie Bartels1
Affiliations: 1Department of Medicine, Rheumatology Division, University of Wisconsin-Madison, 2Center for Health Systems Research and Analysis, College of Engineering, University of Wisconsin-Madison, 3Department of Population Health Sciences, University of Wisconsin-Madison

Engaging Clinic Staff in Work System Redesign to Adapt a Hypertension Protocol for Rheumatology
Authors: Christie Bartels1, Andrea Gilmore-Bykovskyi3, Daniel Panyard4, Courtney Maxcy4, Robert Adsit5, Edmond Ramly2
Affiliations: 1Department of Medicine, Rheumatology Division, University of Wisconsin-Madison, 2Center for Health Systems Research and Analysis, College of Engineering, University of Wisconsin-Madison, 3School of Nursing, University of Wisconsin-Madison, 4Department of Population Health Sciences, University of Wisconsin-Madison, 5Center for Tobacco Research and Intervention, University of Wisconsin-Madison

Fluorescence Lifetime Imaging of Treatment Response in Neuroendocrine Tumor Organoids
Authors: Amani Gillette1, Cheri Pasch2, Chris Babiarz2, Dustin Deming2,3,4, Melissa Skala1,5
Affiliations: 1Department of Biomedical Engineering, University of Wisconsin-Madison, 2University of Wisconsin Carbone Cancer Center, Madison, WI, 3Division of Hematology and Oncology, Department of Medicine, University of Wisconsin School of Medicine and Public Health, 4William S Middleton Memorial Veterans Hospital, Madison, WI, 5Morgridge Institute for Research, Madison, WI

Process Variations in Older Adults’ Care Transitions from Emergency Department to Home: Process Breakdown Versus Process Resiliency
Authors: Nadia Doutcheva1, Nicole E. Werner1, Amy Borkenhagen1, Mary K. Finta2, Joyce Duckles3, Craig R. Sellers3, Sandhya Seshadri3, Denise Lampo3, Manish N. Shah4
Affiliations: 1Department of Industrial and Systems Engineering, University of Wisconsin-Madison, 2University of Wisconsin School of Medicine and Public Health, 3University of Rochester, 4Department of Emergency Medicine, University of Wisconsin School of Medicine and Public Health

PHIM-Typing: Individual Differences in Personal Health Information Management in the Home
Authors: Nicole E. Werner1, Michelle Tong2, Amy Borkenhagen1, Catherine Arnott Smith3, Gail Casper4,5
Affiliations: 1Department of Industrial and Systems Engineering, University of Wisconsin-Madison, 2Department of Biomedical Engineering, University of Wisconsin-Madison, 3University of Wisconsin-Madison School of Library and Information Science, 4University of Wisconsin-Madison School of Nursing, 5Wisconsin Institute for Discovery, Living Environments Lab, University of Wisconsin-Madison
Exploring workload among informal caregivers of patients with dementia
Authors: Nicole E. Werner1, Andrea Gilmore-Bykovskyi2, Connor Pardell3, Rachel Zenker1, Amy J. H. Kind4,5
Affiliations: 1Department of Industrial and Systems Engineering, University of Wisconsin-Madison,
2University of Wisconsin-Madison School of Nursing, 3University of Wisconsin-Madison School of Business, 4Division of Geriatrics, Department of Medicine, University of Wisconsin School of Medicine and Public Health, 5VA Medical Center Geriatric Research Education and Clinical Center (GRECC), Madison, WI

Improving Care for Wisconsin’s Children Using Telementoring
Authors: Jonathan E. Kohler1, Randi S. Cartmill1, Benjamin L. Eithun2, Mary J. Erschen3, Peter F. Nichol1
Affiliations: 1Department of Surgery, University of Wisconsin School of Medicine and Public Health,
2American Family Children’s Hospital, Madison, WI, 3Department of Emergency Medicine, University of Wisconsin School of Medicine and Public Health
Appendix E

WIHSE Inaugural Conference Evaluation Results (N=63 responses)

1. The objective of the WIHSE Inaugural Conference was to “define the healthcare systems engineering research agenda of the future.”

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2. Please rate the speakers, panels and activities

**Thursday, March 16, 2017**

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**Friday, March 17, 2017**

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