6-2009

Board Summary Report June 2009

Regenstrief Center for Healthcare Engineering

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The Regenstrief Center for Healthcare Engineering

The Regenstrief Center for Healthcare Engineering (RCHE) was founded in 2005 as part of Purdue's $350-million interdisciplinary research initiative, Discovery Park, with a mission to apply engineering, management and science principles to transform healthcare delivery. In pursuit of this mission, RCHE harnesses the research expertise of faculty in all of Purdue's academic colleges and schools.

The center's primary goal is to bring a systems-analysis approach to improving the processes of healthcare delivery. While the diagnosis and treatment of patients must remain in the hands of healthcare professionals, the application of engineering, management, and scientific principles has the potential to reshape the healthcare delivery landscape as they have in the automotive, transportation, and retailing sectors.

The center receives core funding from the Regenstrief Foundation. Recognized as an authority on industrial production techniques, Sam Regenstrief believed that engineering and production concepts applied to healthcare delivery would provide better care at lower cost.

The center's work is enhanced by the contributions of affiliated centers and research teams:

- Center for Assistive Technologies (CAT)
- Center for Health Outcomes Research and Policy (CHORP)
- Health Informatics and Learning Technologies (HILT)
- Healthcare Technical Assistance Program (HealthcareTAP)
- PharmaTAP

In addition, the Regenstrief Center is a founding member of the Healthcare Engineering Alliance, connecting academic institutions nationwide in collaborative healthcare engineering research and education.

What is Healthcare Engineering?

In the most general sense, engineering is the practical application of science. Healthcare engineering, therefore, can be thought of as the application of scientific knowledge to the healthcare industry. At RCHE, we apply principles found across engineering, management and science in interdisciplinary research to improve healthcare delivery.

Healthcare engineering approaches the healthcare system and its problems differently than clinical science; however, because healthcare engineering is a relatively new arrival onto the health research landscape, how it fits in is not always intuitive. The best starting place is with a look at methodologies.

Clinical science uses controlled procedures based on statistical theory to evaluate medical results. The most common is the clinical trial. The research method is based upon a comparison of experimental and control groups where the inter-group difference is a single medical intervention — a drug, technique, etc. In observational studies, inferences are drawn on treatment effects. The primary difference between an observational study and a clinical trial is in the assignment of subjects. For an observational study, this assignment is outside the control of the investigator, often because of the impractical nature of the experiment (e.g., a very rare effect) or ethical considerations (e.g., assigning subjects a given disease).

Healthcare engineering uses modeling. The techniques behind this approach create an abstract representation of the system, usually in the form of a mathematical or computer model, to analyze performance. The system representation usually includes multiple variables, both dependent (i.e., a variable whose values are determined by other (independent) variable(s) values) and independent (i.e., a variable whose values are not conditioned by changes in any other variable). This problem representation is then solved by finding values for the independent variables that support the functional need (i.e. dependent variable) yet do not violate the associated equality and inequality constraints.

Why might one choose modeling instead of a clinical trial? Modeling has a number of advantages over experimenting with the actual system, including time, money, risk, or communication. One can examine the effects of a new policy on the system before it becomes a reality (e.g., a new waiver program), test the system under extreme and potentially hazardous conditions (e.g., a pandemic), and examine system effects for which the collection of data would be simply too protracted to be of value (e.g., care cycle management).

Integrated Methodologies

The clinical trial and modeling methodologies are not mutually exclusive. The following example demonstrates how they inform each other and both lead toward creating a system that delivers the best patient care available.

A health system may operate one hospital but multiple satellite clinics in surrounding communities. For this example, let us say that there are 10 clinics. The system wants these clinics to be operating at peak efficiency and in a way that improves care. In engineering terms, this is called the optimal state. How do we establish the optimal state? Once established, how do we achieve this state across all clinics?

The first trial may take one clinic and change elements of that clinic — hours, staffing, rooms available, etc., but not change elements of the other nine clinics. This can establish a preferred state of performance for that clinic. Moreover, using the results of this trial, a model can be built that accounts for the many components that make up clinic performance.

Because the model is grounded in reality — data in the model about the before and after states of the clinic are real — it is able to also project into the future. What is the best combination of patient load, hours, and revenue? While one could experiment with these clinic factors, it would take time, would likely inconvenience and confuse patients and staff, and could be expensive.

The model helps determine the optimal state in which every patient receives excellent care and the revenue goals are being met. As data continues to be collected from the first clinic, it is compared against the model and the model is adjusted as need be. This validates the model and makes its predictions stronger and more accurate.

With one of ten clinics running at optimal performance, there are several options. The remaining nine clinics could undertake the same experimental procedures the first clinic did. This is time consuming and could be expensive. The nine could adopt the same policies, procedures, and changes that the first clinic did; however, all nine clinics may not completely resemble the first clinic. Each of the nine clinic systems can be put into the model created during the clinical trial undertaken with the first clinic. The variables can be adjusted to better match the clinic at hand, and the model can suggest combinations of decisions that, given that particular clinic's operating conditions, would lead it to the optimal state.

RCHE Operations

National Priorities Report

The National Partnership for Priorities (NPP) report, issued in November 2008 by a group representing 28 national healthcare organizations, has been key in directing RCHE's research focus this spring. Similar to the Institute of Medicine's six aims, the six priorities are areas within the healthcare system in which changes are most needed and can make the greatest impact. The NPP identified the following priorities:

1. Patient and family engagement
2. Population health
3. Safety
4. Care coordination
5. Palliative and end-of-life care
6. Overuse

The report was provided to the incoming Obama administration for their consideration as they prepare healthcare reform legislation. Working with this report provides RCHE with the opportunity to network with some of the 28 national organizations who participated in the report and also to better anticipate research directions from some participating organizations.

Because of the timeliness of the report, RCHE chose to focus its spring conference on the priorities, with a goal of identifying research opportunities and challenges, and in particular identifying the areas in which RCHE is best positioned to make an impact. Audience feedback revealed that researchers felt they were most able to help advance research in population health and care coordination, although safety also caught the attention of participants. Several existing projects fit directly into these three areas, and RCHE will explore in greater detail population health and care coordination during the fall conference.

Examples of our work within these priorities are provided here.

Priority Two: Population Health

"Optimizing Long-term Care Resource Allocation for Older Adults Enrolled in Medicaid"

RCHE researchers: Nan Kong, engineering; Mark Lawley, engineering; Laura Sands, nursing; Joseph Thomas III, pharmacy.

Home and community-based long-term care services (HCBS) are considered significantly less costly and a much better match for patient needs than long-term care delivered in institutional settings; yet 80 percent of long-term care continues to be delivered in institutions. There is a need for better resource and service allocation in providing long-term care.

The researchers are developing a model that will assist in creating optimal resource allocation and focuses specifically on adults enrolled in Medicaid. Using Indiana's Medicaid database, they will first establish the optimal number of HCBS and institution slots needed to care for the population. They will then extrapolate on this information to develop a model for how resources could be assigned across both HCBS and institutions to optimize resources and care.
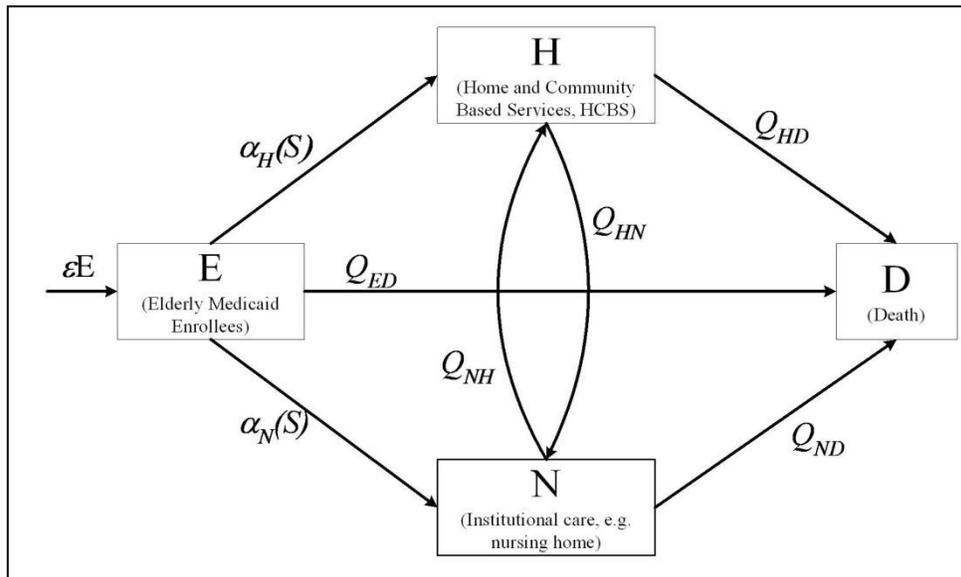
This is the first quantitative analysis of optimal resource allocation of a state's long-term care resources, and it is particularly timely with an aging Baby Boomer population and dramatically increasing Medicaid costs. If more care could be transferred into the community, it could reduce costs, better match patient needs, and free up hospital beds for those patients whose conditions require hospitalization.

Priority Three: Safety

"Creating a Comparative Alaris SmartPump Database"

RCHE researchers: Ann Catlin, information technology.

Infusion IV pumps are only one example of how automation can help reduce errors or overdosing. These SmartPumps dispense medications on schedule and only medical personnel can override the set schedule. The drawback is that because the schedules are overridden so infrequently, even a large hospital does not have enough data to detect patterns in overrides and to use these to address any larger issues.

Through the SmartPump project, researcher Ann Catlin is aggregating data from hundreds of pumps from several health systems. Bringing information from these separate systems to a third-party researcher, Catlin will explore patterns in conditions surrounding overrides that would not have been apparent in smaller data sets. This information will be given back to all participating hospitals to explore in the context of patient and medication safety.
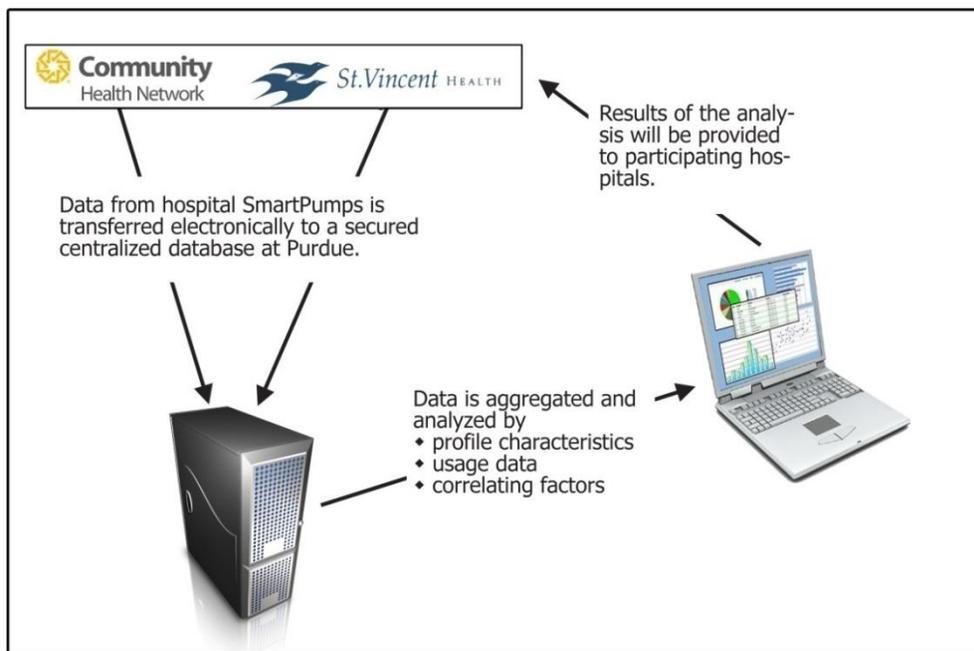
The SmartPump research project aggregates data from two health systems. The RCHE-based server allows the data to be safely transmitted, stored, and aggregated for analysis. The results will be made available to the hospitals after the project so knowledge transfer and improvement can continue.
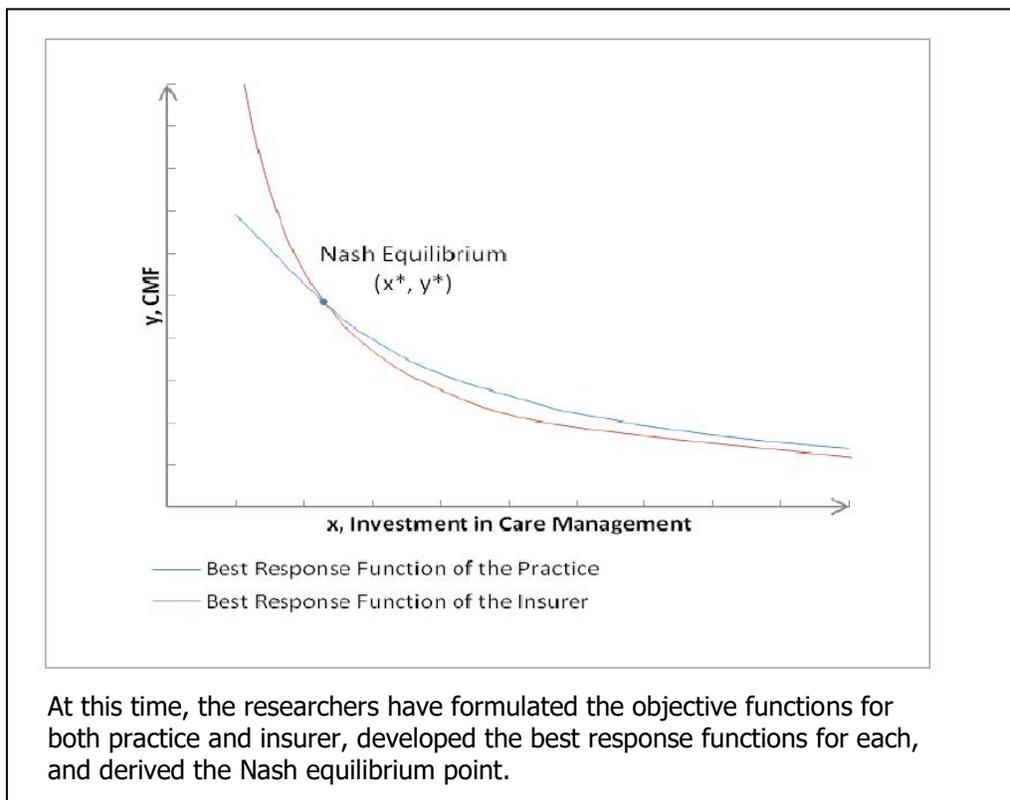
Priority Four: Care Coordination

"Patient-Centered Medical Home Sustainability"

RCHE researchers: Ping Huang, RCHE; Mark Lawley, engineering.

Healthcare is an extremely complex system. Because of this, experiments can be expensive and challenging to organize, and research programs using a single variable can take years to run through the available options.

The Patient-Centered Medical Home (PCMH) is a robust model that takes into account the many variables that make up quality, cost, patient experience, and satisfaction. It will have the ability to evaluate the economic impact, including unanticipated consequences, of different variable changes on physician practices, insurers/payers, and hospitals. The model will permit different assumptions about the patient population, cost to implement, cost savings, payment models, use of health information technology, and quality of care.

While the model is not a substitute for clinical, demonstration projects, it permits the evaluation of many more variables in a shorter time than projects do. The insights gained by running different scenarios through the PCMH model will allow researchers to narrow down which ideas to take to the demonstration phase.

At this time, the researchers have formulated the objective functions for both practice and insurer, developed the best response functions for each, and derived the Nash equilibrium point.

Current Projects

2009 Seed Grants

RCHE reviewed 26 proposals submitted during the 2009 seed grant RFP. Six projects were awarded seed grants of up to $40,000.

Following Doctor's Orders: Does Patient and Spouse Communication with Healthcare Providers Improve Dietary Adherence Among Patients with Diabetes?

Melissa Franks, an assistant professor, and co-PI Cleveland G. Shields, an associate professor, both in the Department of Child Development and Family Studies, will partner with a local endocrinologist to see if coordinating information delivery to patients and their spouses increases treatment adherence.

Using Narrative Persuasion to Increase Colon Cancer Detection in High-Risk Individuals: A Worksite Intervention

Jake Jensen, assistant professor of communication, and co-PIs Mary Anne Sloan, director of HealthcareTAP, and Susan E. Morgan, professor of nursing, will study a worksite campaign attempting to increase colorectal cancer screenings. Other studies have shown that worksite campaigns can be effective, but this is the first study that will look at the narrative aspect as a means to achieving healthcare goals.

The Impact of No-Show Behavior on Diabetes Management

Laura Sands, professor of nursing, and co-PI Mark Lawley of Biomedical Engineering will study the impact of missed appointments on diabetes management efforts. Their research will also look at why appointments are missed, including predictive factors that could be integrated into predictive modeling for better patient scheduling.

Modeling the Supply Chains for Healthcare Products

Lee Schwarz, professor of management, will focus on the consequences of healthcare product misidentification and the development of pharmaceutical distribution revenue models. Unlike consumer goods, healthcare products do not have a well-developed system of identification, distribution, or logistics. The impact begins with inefficiencies and extends into patient-safety issues.

Integrated Data and Trauma Care Outcomes

Joseph Thomas, professor of pharmacy, will use 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 — to examine variation in trauma care and the resulting outcomes. The larger data set will enable him to focus on outcomes other than mortality and to perform a more longitudinal analysis of the data.

Testing an Interactive Web-Based Nutrition Tool in Patients Enrolled in Cardiac Rehabilitation

Ji Soo Yi will develop a pilot project to test "Food Magnet," a web-based tool that can be used to help patients diagnosed with coronary heart disease manage their diet. The tool will be designed so that computer- and nutrition-literacy issues do not limit patients' ability to use it. Yi also will look at the tool's effectiveness in educating patients and in creating behavioral changes in food selections

Affiliated Faculty and Staff

As of May 2009, RCHE has 66 affiliated faculty members.

Unit	Faculty affiliates
Agriculture	1
Medical Education	1
Education	1
Krannert (Management)	2
Consumer and Family Sciences	4
Vet Med	3
Library Sciences	5
Technology	5
Science	6
Liberal Arts	10
Engineering	12
Pharmacy, Nursing, & Health Science	16
TOTAL	**66**

RCHE Affiliated Faculty

Legend:
- Agriculture
- Medical Education
- Education
- Krannert
- Consumer and Family Sciences
- Vet Med
- Library Sciences
- Technology
- Science
- Liberal Arts
- Engineering
- Pharmacy, Nursing, & Health Science
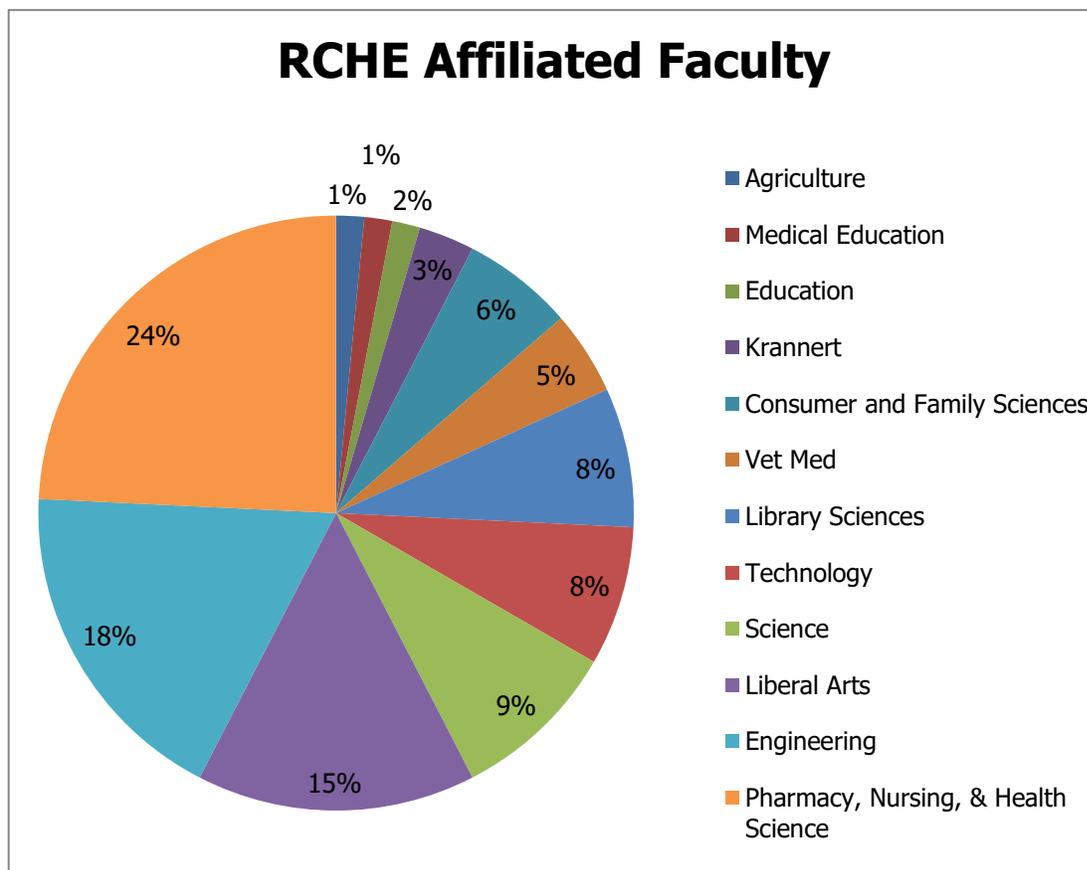
RCHE also attracts staff members throughout Purdue who wish to be affiliated with the center.

Unit	Staff affiliates
Discovery Park administration*	10
Information Technology	1
Human Resource Services	2
Technical Assistance Program	6
TOTAL	**19**

*Includes six RCHE staff members.

Faculty continue to make up the majority of RCHE affiliates.

RCHE Affiliated Faculty and Staff

- Faculty 78%
- Staff 22%
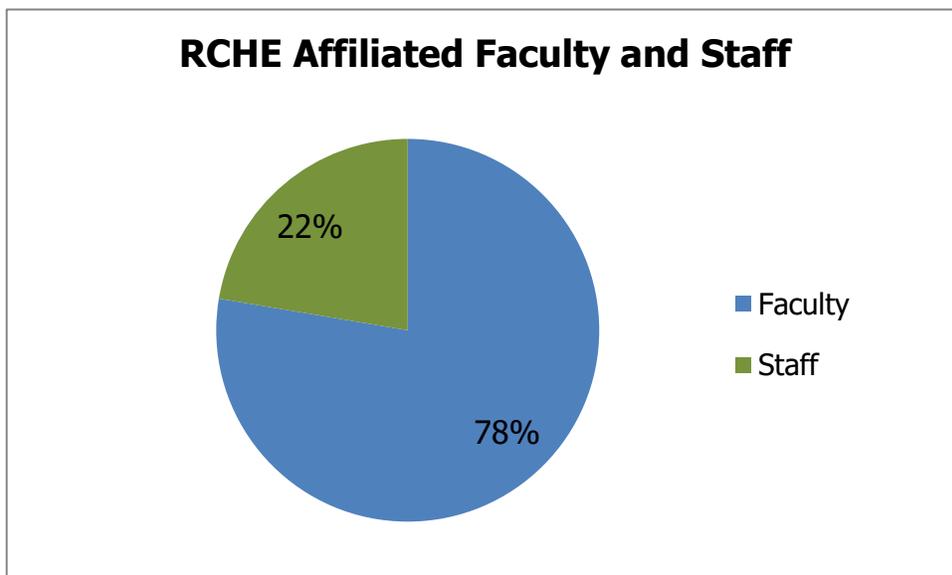
Communications

RCHE continues to use electronic communications as primary vehicles. As part of its commitment to disseminating healthcare information in user-friendly methods, the website was redesigned, including a navigation review, in February 2009. A newsletter redesign followed in April 2009.

Total newsletter subscribers: 246

Research Effectiveness

Research Partners

RCHE continues to build both living laboratory and national dissemination partnerships. Currently, we have active partnership agreements with:

- American College of Physicians

- Ascension Health

- Community Health Network

- Indiana Hospital Association

- Indiana State Department of Health

- IU Medical Group

- IU School of Medicine

- Mayo Clinic

- St. Vincent Health

- U.S. Department of Veterans Affairs

- VHA Inc.

- Wellpoint

Research Validation

The Regenstrief Center for Healthcare Engineering seeks external sources of information to validate the focus and quality of its research. In addition to the input of our partners, RCHE derives useful information from competitive funding, publication in peer-reviewed journals, professional conference presentations, and advice from our advisory council. This year, the following have helped to further focus RCHE's research direction:

- Washington, DC, meetings with American Hospital Association (AHA), Agency for Health Research and Quality (AHRQ), the American College of Physicians (ACP), and the National Science Foundation (NSF).

- National Partnership for Priorities report

Invited Professional Presentations

- *3rd Annual INFORMS Workshop on Data Mining and Health Informatics* Elman A, Kong N, Bartlett E, Otto K. "Analysis of Sensory Transformations in Response to Complex Sensory Stimuli in the Auditory Pathway." Washington, DC, October 11, 2008.

- Chen X, Brian I, Kong N. "Temporal Prediction Models for Mortality Risk among Patients Awaiting Liver Transplantation." Washington, DC, October 11, 2008.

- Teng Y, Kong N. "Applying Agent-based Modeling and Simulation (ABMS) to the U.S. Organ Transplantation and Allocation Network." Washington, DC, October 11, 2008.

- *Gerontological Society of America's 61st Annual Scientific Meeting.* November 22-24, 2008. "Amount of Attendant Care is Associated with Risk of Hospitalization among Medicaid Waiver Recipients with Dementia." Researchers: Laura P. Sands, PhD, Purdue Nursing; Huiping Xu, PhD, Purdue Statistics; Sudeshna Paul, MS, Purdue Nursing; Michael Weiner, MD, Indiana University School of Medicine; Caroline Doebbeling, MD, Indiana Office of Medicaid Planning and Policy; Emily Hancock, PhD Indiana Office of Medicaid Planning and Policy; Joseph Thomas III, PhD, Purdue Pharmacy Practice

- *National Cancer Institute Technical Workshop – Methodological and Conceptual Issues in Conducting Research on Racial/Ethnic Discrimination in Health Care Delivery.* September 29, 2008. "Using Standard Patients to Measure Discrimination in Health Care Delivery." Presenter: Cleveland Shields, Purdue Child Development and Family Studies.

- *American Academy on Communication in Healthcare Conference.* October 17-19, 2008, Madison, WI. Interdisciplinary Research between Purdue & IU School of Nursing Psycho-Oncology Intervention: Breast Cancer Survivor Activation Study." Presenter: Cleveland Shields, Purdue Child Development and Family Studies

- *Presented at the 2008 meeting of the American Geriatrics Society, Washington DC.* Sands LP, Daggy J, Campbell W, Flynn M, Lemon A. Obesity and need for long-term care services. Journal of the American Geriatrics Society, 56(4), 2008.

- *Presented at the 61st annual meeting of the Gerontological Society of America, National Harbor, MD.* "Amount of Attendant Care is Associated with

Risk of Hospitalization among Medicaid Waiver Recipients with Dementia."
Sands LP, Xu H, Paul S, Weiner M, Doebelling C, Hancock E, Thomas J.

- *Safety Across High-Consequence Industries Conference, St. Louis, MO, September 12, 2008.* "Healthcare Engineering: Applying Engineering Principles and Techniques to Healthcare Challenges."
Ken Musselman

- *Tecnologico de Monterrey, San Luis Potosi, Mexico, April 1, 2009.* "Industrial Engineering in Healthcare Services."
Ken Musselman

- *Tecnologico de Monterrey, San Luis Potosi, Mexico, April 2, 2009.* "Multidisciplinary Research in Healthcare Delivery."
Ken Musselman

- *Keynote Address. Convencion Nacional del Institute of Industrial Engineers, Region Mexico, San Luis Potosi, Mexico,* April 3, 2009. "Reshaping Healthcare Delivery through Industrial Engineering."
Ken Musselman

- *Proceedings of the National Science Foundation Awardees Conference, June 2009, Honolulu Hawaii.* "Sequential Appointment Scheduling with No-show for Continuos Consultation Periods." Chakraborty, S., Muthuraman, K., Lawley, M.

- *JSM 2009 Meeting; Washington, DC, Health Statistics Track.* "Joint modeling of zero-inflated data using copulas." Joanne K. Daggy, Purdue University; Bruce A. Craig, Purdue University; Joseph Thomas, III, Purdue University

Advisory Council

The RCHE advisory council met on April 22. The group discussed further focus of RCHE's research areas, particularly as they apply to the National Partnership for Priorities report, and the expansion of the fall conference from a Purdue focus to a national focus. Suggestions from the group are being incorporated into the planning of RCHE's fall conference.

Research Collaboration

RCHE collaborates with other universities and centers at Purdue to further the field of healthcare engineering and develop research projects and proposals whose impact can reach beyond Purdue. Below are partnerships and some recent results of partnerships.

Science and Technology Center for Advanced Healthcare Delivery

RCHE was invited to participate in this NSF proposal with lead institution North Carolina State University, another member of the Healthcare Engineering Alliance. If funded, the center will develop a learning and knowledge base on the quantitative methods of the cycle of care for either cancer or heart disease. Unlike demonstration projects, this knowledge base will be able to be extended to other care cycles and related domains, thus informing other areas of healthcare research.

Brown Bags

This spring's Brown Bag Lunch program was coordinated by RCHE but was a collaborative effort with the Oncological Sciences Center (OSC), the Center for Aging and Life Course (CALC), and a graduate-level nursing course taught by RCHE faculty member Laura Sands.

Regenstrief Institute

RCHE continues to develop projects in collaboration with the Regenstrief Institute. Several student fellows have been placed through the Institute. The Institute is significantly involved in the Cancer Care Engineering research project. Additionally, RCHE faculty affiliate Laura Sands, PhD, is working on a data mining research project in conjunction with the Institute and several faculty from the IU medical school. Currently, the Institute and RCHE are collaborating on projects surrounding the stimulus bill, health information technology, and the health information exchange.

New IIE Healthcare Engineering Professional Journal

The Institute of Industrial Engineers, a professional organization in which many RCHE engineers are members, has recently launched a new healthcare engineering journal. The first issue is due out in 2010. RCHE strategic collaborations director Ken Musselman was the organization's president during the time that the journal was created and launched.

Learning and Innovation

Spring Conference

RCHE's spring 2009 conference centered on the National Priorities Partnership report, *National Priorities and Goals*, released in November 2008. Seven speakers representing different perspectives on the priorities addressed challenges and paths to achieving the goals. The speakers also highlighted areas where Purdue researchers could make the greatest impact.

The speakers were:

- Karen Adams, vice president; National Quality Forum;

- Michael Barr, vice president Practice Advocacy and Improvement; American College of Physicians;

- Virginia Caine, director, Marion County Health Department;

- Harvey Fineberg, president, Institute of Medicine;

- Cerry Klein, program director, Service Enterprise Engineering, Manufacturing Enterprise Systems; Division of Civil, Mechanical & Manufacturing Innovation; National Science Foundation;

- Stephen Mayfield, senior vice president, Quality and Performance Improvement; director, AHA Quality Center; American Hospital Association;

- David Meyers, director, Center for Primary Care, Prevention, and Clinical Partnerships AHRQ.

During a feedback session at the end of the conference, participants overwhelmingly responded that population health and care coordination were the areas in most need of research and also the ones they could most envision themselves working in.

Post-conference feedback has been very positive. The feedback survey received a 25 percent response rate. 100 percent of respondents said that the conference met or exceeded their expectations; 100 percent would also attend another RCHE conference. Suggestions from the survey are being considered in the planning of the fall conference.

Speaker Series

The RCHE Speaker Series continues to attract regional and national speakers. By sharing their experience with students and faculty, the speakers help further current RCHE research as well as contributing to healthcare engineering education at Purdue. Spring 2009 speakers included:

- Dr. Beverly Malone, CEO National League of Nurses

- Ken Ferraro, Director, Center on Aging and the Life Course, "Physical Health in Later Life"

- Eric Scherer, PhD, Roudebush VA Medical Center, "An adaptive-predictive model for colonic neoplasia incidence"

- Brad Doebbeling, Director, Health Services Research, Regenstrief Institute, Inc.

- Shelley Macdermid, Director, Center for Families, "Interdisciplinary Research"

- Stacey Mobley, Assistant Professor, Foods & Nutrition, "Healthy Purdue"

- Dorothy Teegarden, PhD, Cancer Center, OSC- "Vitamin D in Cancer Prevention"

Pioneer Speaker

Harvey V. Fineberg, President, Institute of Medicine

April 16, 2009

The Best-Buy Proposition in Healthcare: Quality, Efficiency, and Value

Financial Management

Awards

Full award amounts are reported in the year in which RCHE is notified of the award. Grant funders in 2008–09 include:

- National Institutes of Health
- PHS-NIH National Cancer Institute
- U.S. Department of Health and Human Services
- Lilly Seed Grant Program
- U.S. Department of Defense
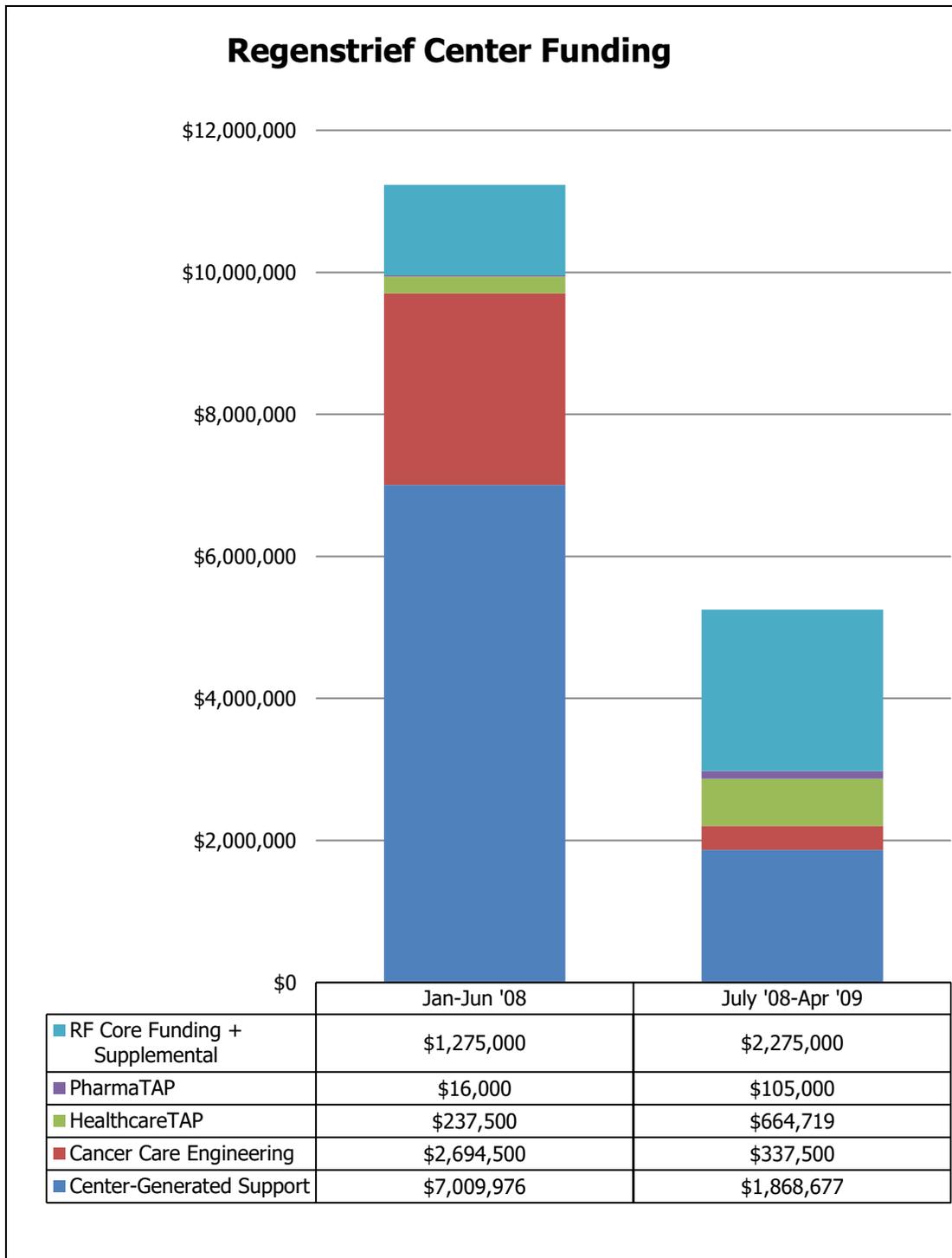- Indiana State Department of Health

Multi-Year Awards

Many of RCHE's grants are multi-year awards, in which the total funding and project work are distributed over several years. The "**R**" indicates the year in which the grant was received and the amount reported to the board. Project work continues during the shaded years.

Project Title	Total Award	Length	'06-'07	'07-'08	'08-'09	'09-'10	'10-'11	'11-'12	'12-'13
Cancer Care Engineering	$2,177,000	4 yrs		R					
Center for Assistive Technologies	$1,486,346	3 yrs		R					
Year 2 Pandemic Exercise Preparedness	$658,645	2 yrs		R					
Framework for Adoption	$408,333	3 yrs	R						
Tri-State Telehealth Resource Grant	$88,141	3 yrs	R						
CTSI (Current RCHE portion)	$46,935	5 yrs			R				

Examples of Funded Projects in 2008–09

| Project title	Award
Racial Differences in Physician-Patient Communication for Cancer Pain Management	$195,083
Women's Oncological Research and Development (WORD)	$140,000
Work Process Design Strategy to Reduce Barcode Medication Administration (BCMA) Workarounds for Improved Patient Safety	$50,000
Alaris Smart Pump Safety	$29,543
Proximity to Uninsured Populations and Hospital Services	$9,728

2008-09 Financials

Regenstrief Center Funding

	Jan-Jun '08	July '08-Apr '09
■ RF Core Funding + Supplemental	$1,275,000	$2,275,000
■ PharmaTAP	$16,000	$105,000
■ HealthcareTAP	$237,500	$664,719
■ Cancer Care Engineering	$2,694,500	$337,500
■ Center-Generated Support	$7,009,976	$1,868,677

Note: In this graph, multi-year grants are reported using the total grant amount reported during the year in which RCHE was notified of the award. CTSI is not included in this graph.

RCHE continues to secure funding from external partners and to leverage the core funding from the Regenstrief Foundation. To date, RCHE's funding is at a higher level than projected during the 2007 renewal.

Regenstrief Center Cumulative Funding
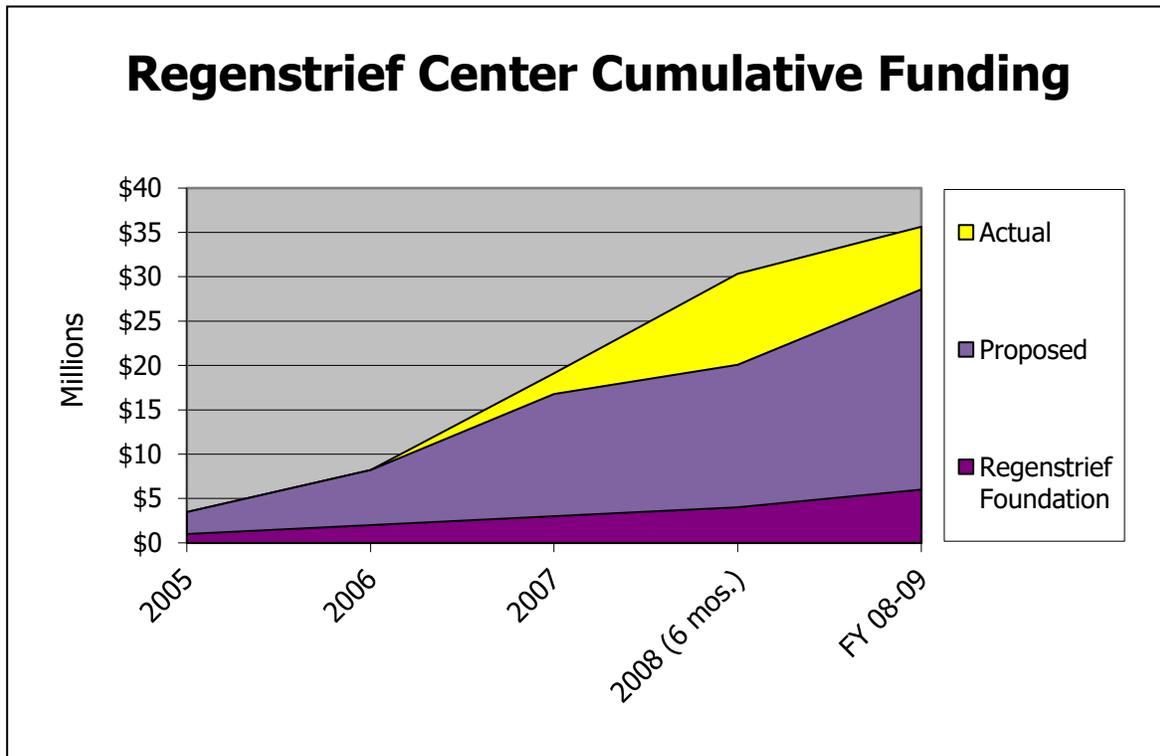
Note: CTSI is not included in graph.