An introduction to the Regenstrief Center for Healthcare Engineering

June 14, 2017
Topics

- Background
- Strategic areas and goals
- Example projects
A little history...

Sam Regenstrief

“I can go anywhere in the world to get health care…but these people have no choice…surely to God there is something we can do about this!”
Pursue a transformed healthcare delivery system by conducting impactful research guided by national priorities and leveraging collaborative partnerships.
Cross-cutting Centers
• Bindley Bioscience Center
• Birk Nanotechnology Center
• Burton D. Morgan Center for Entrepreneurship
• Purdue Center for the Science of Information
• Purdue Policy Research Institute

Impacting Global Health
• Purdue Institute of Inflammation, Immunology and Infectious Disease
• Purdue Institute for Integrative Neuroscience
• Purdue Institute for Drug Discovery
• Regenstrief Center for Healthcare Engineering
• Women’s Global Health Institute

Impacting Global Sustainability
• Center for Global Food Security
• Center for the Environment
• Energy Center
• Purdue Climate Change Research Center

Impacting Global Security
• Institute for Global Security and Defense Innovation
• VACCINE
| **Purdue Healthcare Advisors (PHA)** | 35 Employees; outreach arm of RCHE; 3 service lines:  
- Quality reporting, IT security, Lean/agile implementation  
- Funding: CMS, state agencies, providers |
|-------------------------------------|-------------------------------------------------------------------------------------------------|
| **RCHE faculty and research scientists** | 10 full time staff, faculty, and research scientists;  
- IE, CS, statistics, mathematics  
- Funding: NIH, NSF, foundations, providers, etc. |
| **Affiliated faculty and clinicians** | Faculty from CS, nursing, pharmacy, statistics, management, BME, IE, stat, math, public health, public policy |
PURDUE HEALTHCARE ADVISORS

QUALITY REPORTING
- Great Lakes Practice Transformation Network
  - Preparing providers for value-based care

HEALTH IT SECURITY
- Assessing IT security risk / HIPAA compliance for hospitals and practices

PROCESS IMPROVEMENT
- Lean First
  - Training healthcare professionals to be Lean practitioners and Lean leaders

- Healthy Hearts in the Heartland
  - Researching and improving cardiovascular care in small practices

- Indiana Family and Social Services Administration
  - Helping providers use electronic health records (EHR) systems in meaningful ways

- Building process-improvement competencies in critical access hospitals

- Indiana State Office of Rural Health
  - Providing a community of practice for Lean healthcare practitioners

- Community of Practice
  - Operational excellence in healthcare at Purdue University
Examples of Current PHA Projects

- Great Lakes Practice Transformation Network – 3,300 providers, healthcare transformation
- IN Medicaid – 150-200 organizations, health IT/security
- IN State Office of Rural Health – 14 CAHs, lean transformation
- Oregon – 4 hospital rural health clinics, lean process improvement
- IN State Department of Health – lean process improvement
- Underserved hospital - lean value stream
- Independent suburban hospital - ED value stream
Our Intent – Research Access/Dissemination

- Healthcare providers have many unresolved complex issues
- PHA has access, innovation, and dissemination capacity throughout IN
- RCHE can bring to bear Purdue’s intellectual/research/innovation capabilities

PHA established this type of relationship with Northwestern University (Healthy Hearts in the Heartland $15M grant) and the IU School of Medicine ($50M Practice Transformation Network proposal).
RCHE Staff

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Statistics
Regenstrief National Center for Medical Device Informatics (REMEDICENTRAL)

- 2009: Medication errors related to infusion therapy. Top the list for adverse events occurring in hospitals. To promote and improve patient safety, Regenstrief Center for Healthcare Engineering at Purdue University founded Infusion Pump Informatics as an evidence-based community of practice.
- 2009: Begins tracking alarms generated when medical personnel program "smart pumps" (i.e., infusion pumps programmed with Drug Error Reduction Features) to ensure adherence to prescribed limits.
- 2013: Begins tracking the activation of "smart pump" technology on infusion pumps. Do clinicians turn it on?
- 2015: Expands scope to form Informatics-based communities of practice around additional medical devices.
- 2016: Forms REMEDI Central, an online site for medical device data, benchmarking, analysis, and research results.
- 2016: Creates a Drug Limit Library, which acts as a repository for concentrations and soft/hard maximums/minimums for infused drugs; and introduces a standard profile and drug mapping for easier comparisons.

Promotes research on poverty as well as other social determinants of health inequities.
Our strategic areas

• Supplementing evidence-based practice with evidence obtained from linking observations process data to outcomes
• Supporting an adaptive healthcare continuum by effectively matching resources with demand
• Improving health and wellness in the rural community
Building evidence-based practice based on the linkage of process observations to outcomes

Patient Data (EHR/PRO)
- Morbidity, mortality, length of stay, quality of life, etc.

Data Models
- Causal Reasoning
- Machine Learning

High Performance Computing

Current Evidence

Process Model

Evidence-based process recommendation

Process
- Medical device data, real time location, care pathways, etc.

Personalized care

Population-based care

Events
Supporting an adaptive healthcare continuum by effectively matching resources with demand
Improving health and wellness in the rural community

Access to care
Evidence-based interventions
Point of care diagnostics
Technology Adoption

Only 10% of the variability in health outcomes is attributable to healthcare (behavioral, social, genetic predisposition)
CULTURE OF HEALTH ACTION FRAMEWORK

ACTION AREA 1
MAKING HEALTH A SHARED VALUE

ACTION AREA 2
FOSTERING CROSS-SECTOR COLLABORATION TO IMPROVE WELL-BEING

ACTION AREA 3
CREATING HEALTHIER, MORE EQUITABLE COMMUNITIES

ACTION AREA 4
STRENGTHENING INTEGRATION OF HEALTH SERVICES AND SYSTEMS

OUTCOME
IMPROVED POPULATION HEALTH, WELL-BEING, AND EQUITY

EQUITY
A Few Examples
REMEDI - AN EVIDENCE BASED COMMUNITY OF PRACTICE

- 100+ report types
- Alert, compliance & library data
- Analyze your data
- Benchmark/Compare to others
- Vendor neutral
- Compliments vendor analytics

- 270+ Facilities across 23 states
- 28.3 Million alerts
- 102.1 Million infusions generate Compliance
- 44,700 Reports generated
- Baxter, BD, Pfizer, and Smiths Medical data
USE CASE – COMPLIANCE BENCHMARKING
Drug Library Update Cycles

![Graph showing alert count over time with different update cycles and their intervals.]

- **Alert Count**
- **Date (Month-Day)**
- **Start of d.s. 210**
- **Start of d.s. 209**
- **End of d.s. 210**
- **End of d.s. 209**

Legend:
- **210**
- **209**
- **211**
CURRENT STEPS

- Link REMEDI data to the EHR
  - Pilot project with IU Health and Geisinger

- Broader goal is to help link process data (medical device, RTLS, etc.) to outcomes
  - Infusion
  - Care pathways for HAIs/sepsis
  - Handwashing
  - Capacity management
Approach

Activity Template

For each therapy

Drug model building

• Individual-based PK/PD modeling
• Bayesian inference methods
• Regimen design

Multi-site study

• Feasibility
• Integrated workflows

Drug APP

Web-based CDSS

Case sharing

Single site study

Hub

Focus: drugs with narrow therapeutic index

Transplant

cyclosporine

pediatric

acute anticoagulation treatment

heparin

Sepsis

vancomycin

adult

Cancer

geriatric

melphalan

Drug APP Web-based CDSS Hub Case sharing

Activity Template For each therapy Drug model building

Single site study

Multi-site study

Drug APP
Preventable Hospital Readmissions

Robert is a Medicaid patient admitted with a blood disorder. He stayed in the hospital for 6 days with a disease severity level of 3 having a hospitalist as his attending physician. He is legally separated and is being discharged to home. He was in the hospital 15 days prior.

Li is a commercially insured patient admitted with a nervous system disorder. She stayed in the hospital for less than 24 hours with a disease severity level of 1. She is married and is being discharged to home. She was in the hospital 180 days prior.

Risk of 30-Day Readmission

4%  29%
## 30-Day Readmission Risk Assessment

<table>
<thead>
<tr>
<th>Name</th>
<th>Mary Stewart</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient ID</td>
<td>4</td>
</tr>
<tr>
<td>Current Date</td>
<td>April 18, 2014 08:25 AM</td>
</tr>
<tr>
<td>Discharge Date</td>
<td>Saturday, April 19, 2014</td>
</tr>
<tr>
<td>Principal Diagnosis</td>
<td>16.10 Complications</td>
</tr>
</tbody>
</table>

### Risk Rating:
- **Average**

### Preventable Readmission Risk
- **7%**
- More likely to be readmitted than **48%** of patients

### Recommended Intervention(s):
- Enhanced Discharge and Scheduled Follow-up

### Other Available Intervention(s):
- Transition Coach
- Post-Discharge Phone Call and Home Visit
- Virtual Nurse
- Medication Reconciliation
- Language Assistance
- Teach-Back Discharge Plan
Access to preventive oral health in children

- Dental caries is the most prevalent unmet health need among U.S. children.
- Almost 25% of US children living in poverty have untreated caries, which, if left untreated, can lead to problems with eating, speaking, and learning.
- Although preventive dental services (pit-and-fissure sealants (SEA) and topical fluoride (TFL)) are effective in preventing caries, <9% of low-income children received at least one of these services in 2009.
- Increasing utilization of preventive dental services among low-income children is a national health goal.
<table>
<thead>
<tr>
<th>State</th>
<th>Number of Children</th>
<th>No fluoride or sealants</th>
<th>Sealants only</th>
<th>Fluoride only</th>
<th>Sealants and fluoride</th>
</tr>
</thead>
<tbody>
<tr>
<td>Georgia</td>
<td>(n=164,185)</td>
<td>%</td>
<td>55%</td>
<td>4%</td>
<td>31%</td>
</tr>
<tr>
<td></td>
<td>Expenditures per child per year</td>
<td>$209</td>
<td>$96</td>
<td>$135</td>
<td>$93</td>
</tr>
<tr>
<td>Texas</td>
<td>(n=425,876)</td>
<td>%</td>
<td>59%</td>
<td>6%</td>
<td>24%</td>
</tr>
<tr>
<td></td>
<td>Expenditures per child per year</td>
<td>$303</td>
<td>$233</td>
<td>$250</td>
<td>$157</td>
</tr>
</tbody>
</table>

- Over **seven** years, a child who had topical fluoride as preventive care before caries treatment costs **$518 less** if he/she hadn’t
- Over **seven** years, a child who had topical fluoride and sealants as preventive care before caries treatment costs **$812 less** if he/she hadn’t
Impact on Medicaid

• If 20% of young children In would have utilized preventive dental care starting in 2011:

• Georgia
  • Medicaid would have saved $7.0M/year if those children would have had fluoride regularly (>= 1 time per year) and sealants at the appropriate age
  • 20,600 averted caries

• Texas
  • Medicaid would have saved $25.8M/year
  • 69,400 averted caries
• Only 33% of Georgia dentists accept Medicaid
• In 54 counties, demand was more than double supply
• Travel for Medicaid enrolled children on average 10 miles greater (urban) and 20 miles (rural) that privately insured counterparts

• Strategies that could increase access:
• School-based dental sealant programs
• Increasing primary care providers’ provision of fluoride varnish
• Allow dental hygienists to provide preventive dental services
HIV in IDU Community in Indiana

- Scott County went from 1 new HIV infection per year from 2005 to 2015 to 194 new infections by June of 2016
- CDC has identified 220 vulnerable counties in the US
- Goal is to develop and HIV outbreak model that informs state public health programs on impact of various interventions
A network is an accurate representation of IDU community because it can capture their attributes and different types of relationships.

**Nodes**
- Person
  - Demographic attributes used
  - Disease parameters utilized

**Edges**
- Relationship Types
  - Syringe sharing
  - Sexual Relationship
  - Disease parameters utilized

**Network**
- Composed of
  - Nodes
  - Edges
  - Network statistics utilized

Network Model:
- = Viral Suppression
- = Infected Acute
- = Infected Chronic
- = Susceptible

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- = Syringe Sharing
- = Sexual Relation & Syringe Sharing
**Cost-Effectiveness Results**

**Cost-Effective Intervention:** For SEP, 23 of 24 simulation scenarios run resulted in cost-effective scenarios. ART and PrEP together had 8 cost-effective scenarios.
Task reallocation in Nursing: Prevalence and Outcomes

Benjamin B. Dunford Ph.D.
Benjamin R. Pratt, Doctoral Student
30.9% Of nurses indicated that infusion teams have been disbanded or reduced in their place of work. Why?

- To reduce costs
- Technology makes them unnecessary
- Regulatory/reimbursement pressures
- Lack of organizational resources
- Individual nurses perform them just as well
Medication Errors and Severity of Harm

• 60% of serious and life threatening errors is associated with Intravenous (IV) medication infusions

• Different magnitudes of harm:
  - NCC MERP Index: Category A-I
    (No Error, No Harm) - (Error, Death)
  - Adverse drug events (ADEs):
    “any medication error reaching to patients and causing a small or large injury resulting from IV medication infusion”

Evaluation of IV Drug Infusion Performance

- Define/Revise Drug Limits
- Update Drug Limits on Pumps
- Program Infusion Parameters
- Administer Drug Infusions

Drug Limit Library

- What cause Issues?
  - Workflow
  - Nurse
  - Other

- Improve Workflow Design
- Improve Nurse Training
- Other (e.g. Improve Communication)

Evaluate Drug Infusion Performance

- Evaluate Safety Issues?
  - YES
    - Improve Workflow Design
    - Improve Nurse Training
    - Other (e.g. Improve Communication)
  - NO
    - Stop

Source: Cure et al. (2014); The National Patient Safety Agency (2007)

Most existing analysis tools evaluate performance: Number of alert frequency
Initial Data Collection:
Risk Perception - Nurse v.s. Pharmacist

Example: AICU - Propofol - Continuous Dose - Soft Max Drug Limit (100 mcg/kg.min)

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Infusion Rate (mcg/kg.min)</th>
<th>Total drug amount patient received (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS1</td>
<td>110</td>
<td>170</td>
</tr>
<tr>
<td>SS2</td>
<td>110</td>
<td>590</td>
</tr>
<tr>
<td>SS3</td>
<td>110</td>
<td>1000</td>
</tr>
<tr>
<td>SS4</td>
<td>130</td>
<td>170</td>
</tr>
<tr>
<td>SS5</td>
<td>130</td>
<td>590</td>
</tr>
<tr>
<td>SS6</td>
<td>130</td>
<td>1000</td>
</tr>
<tr>
<td>SS7</td>
<td>150</td>
<td>170</td>
</tr>
<tr>
<td>SS8</td>
<td>150</td>
<td>590</td>
</tr>
<tr>
<td>SS9</td>
<td>150</td>
<td>1000</td>
</tr>
</tbody>
</table>

In this scenario type, nurse perceived less risk of IV harm
Questions?

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Methods

• Medicaid MAX claims data for 6 states (AL, GA, MS, NC, SC, TX)
• Followed 930K Medicaid-enrolled children over 7 years
  • Aged 3 to 6, “healthy” as defined by clinical risk group, enrolled in Medicaid at least 5 of 7 years
  • Extracted all dental-related claims
• Clustered into 4 groups based on Markov renewal process and unsupervised classification algorithm:
  • Group 1: neither receiving TFL repeatedly nor SEA
  • Group 2: receiving SEA only
  • Group 3: receiving repeated TFL only
  • Group 4: receiving both TFL and SEA