Using Modeling to Improve Outcomes: Archimedes example

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www.archimedesmodel.com
Overview

• Healthcare modeling company
• Based in San Francisco
• Core technology - Archimedes Model
  – Mathematical model of human physiology, diseases, interventions, and healthcare systems
    ▪ Highly detailed
    ▪ Carefully validated
  – In development since 1993
  – Founders
    ▪ David Eddy MD, PhD
    ▪ Len Schlessinger PhD
• Owned by Kaiser Permanente
  – Spun out as independent organization 2006
Archimedes Clients and Collaborators

(Not all can be shown)
Using the Model to Examine Heart Disease Population Interventions

Targeting a Specific Population with a Drug Combination to Improve Health Outcomes and Reduce Costs (A-L-L)
Structure of Simulation

**WHO**
- Patients with CAD and all diabetics over 55 years in KP California

**WHAT**
- Experimental Group: Aspirin, Lisinopril, Lovastatin
- Reference Group: 1% HbA1c reduction
- Control Group: Current care

**WHEN**
- 25-year simulation (followed by 2-year real trial)

**OUTCOMES**
- Annual risk of: MI, stroke, ESRD, blindness, death
- Annual cost
Setup

• For Patients with CAD and/or DM (for diabetics over 55 years of age)
  – Aspirin
  – Lovastatin
  – Lisinopril

• Keep it simple
  – As few visits and tests as possible
  – Don’t strain to reach a goal
  – Just make sure they get it
The Effect Begins Immediately

Annual risk of four complications or death

- **Nothing**
- **ALL**
- **HbA1c**

Time since start of program

0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0
0 5 10 15 20 25
It Saves More Money

Average annual cost per person

Cost

$0

$500

$1,000

$1,500

$2,000

$2,500

$3,000

$3,500

$4,000

$4,500

$5,000

Nothing

HbA1c control

ALL
The Savings Begin Immediately

Annual cost per person

Years after start of program

- **Nothing**
- **ALL**
- **HbA1c**
A-L-L has a Bigger Effect than 1% HbA1c Reduction

Average annual risk of various events

- MI
- Stroke
- ESRD
- Blind
- Dying

- Nothing
- HbA1c control
- ALL
Independent Evaluation (2007)

- In 2004-2005, 28% of KP’s eligible study population in Northern + Southern CA (n=170,024) had received A-L-L at low exposure, 13% at high exposure (59% no exposure)

- Modeled results consistent with actual findings by KP’s Care Management Institute:
  - By 2006, heart attacks and strokes decreased by 15 per 1000 members for the low-exposure group (p<0.05), and 26 per 1000 for the high-exposure group (p<0.05)
  - 1,271 hospitalizations prevented in 2006
  - Net savings of $38M/year among the study population

- Estimated net savings of $120M per year if fully implemented among all of Kaiser’s eligible patients

- If extended to 10% of U.S. diabetics, potential savings of $1B/yr
Archimedes Technology Concept

Public Databases, Clinical Trials, Observational Studies, Epidemiological Data

Archimedes Model

EMR and HRA Data

Consulting Services

Archimedes Healthcare Simulator

IndiGO™ Individualized Guidelines and Outcomes
CMI Publication of Findings, 2009

• National publicity of Archimedes’ modeling for Kaiser’s A-L-L intervention

  – HEALTH CARE REFORM
    October 1, 2009
    A Kaiser Permanente study shows patients can ward off heart attacks and slash medical expenses with a simple generic drug regimen.
Archimedes Tools

• ARCHeS
  – Software as a Service application that enables simulation and analysis of interventions and programs for populations and subpopulations
  – Designed for healthcare administrators and policy makers
  – Case example: ALL project

• IndiGO
  – Point of care tool that suggests individualized treatment guidelines (combo of medications and behavioral changes) based on specific individual information and has been shown to improve compliance with physician recommendations
    ▪ Covers cardiovascular disease, diabetes and its complications, and screening for breast and colon cancer
    ▪ Has application for population management as well
  – Case example: Pilot in KP Hawaii
ARChES Innovator

- Funded by Robert Wood Johnson Foundation
- Access to significant portion of Archimedes Model via Software as a Service (SaaS)
- Includes online interface to define simulation criteria and analyze outcomes
- Currently covers conditions, treatments, and outcomes related to cardio-metabolic risk (additional diseases added with each release)

www.archimedesmodel.com/arches-innovator
ARCheS Innovator Architecture

- **ARCheS Setup Tool**
  - User defines study for simulation on Archimedes Model
    - Population of interest
    - Background care
    - Standard or custom interventions

- **Archimedes Model**
  - Simulates study on Archimedes’ grid computing facility
  - Generates health and economic outcomes over a twenty-year virtual time period

- **Outcomes Analyzer**
  - User can visualize and analyze resulting forecast dataset
  - User can modify assumptions such as compliance, disutility weights, costs, subpopulations, etc.
Formulating a Problem for Analysis

• Identify the decision(s) to be made
• Every decision has two steps

Information → Analyze Alternatives → Preference Judgment

Compare Benefits, Harms and Costs → Decision

Outcomes of Each Alternative
Think of a trial or intervention to test: ARCHeS Setup Tool Does This

• Setting
  – Population: US population
  – Care processes: levels of care currently seen in US
  – Costs: Medicare costs
• Community population: user defines
• Care in the control group: user specifies current care or no care
• Interventions and their target populations: user defines
• Arms of the trial: user defines interventions and adherence
• Outcomes of interest: > 30 outcomes pre-specified
IndiGO

Point of care tool that suggests individualized treatment guidelines (combo of medications and behavioral changes) based on specific individual information
Improving the content of care

• Current guidelines have inherent limitations because they were designed for use without computers:
  • Focus on one variable at a time (e.g., BP)
    • Ignore other risk factors
  • Use sharp thresholds (e.g., SBP > 140)
    • Ignore the continuous nature of risk factor
  • Example: National guideline for hypertension
    • “Treat if SBP > 140, or if have diabetes, treat if SBP > 130

• It is now possible to design more effective guidelines that will simultaneously improve quality and lower costs
IndiGO: Pilot in KP Hawaii

Pilot Study

- IndiGO was implemented by KP Hawaii and independently evaluated by the KP Care Management Institute (CMI)
- All physicians were using EPIC and had access to a decision support tool that identified care gaps according to current guidelines (“standard care”)
- Primary care physicians at two clinics were provided access to IndiGO, in addition to EPIC and the care gap tool
- Results for patients exposed to IndiGO were compared to two different matched control groups

Findings

- Increased patient adherence
  - Candidates for statins showed 6-fold increase in use
- Improved outcomes
  - A 13% reduction in 5-year CVD risk, compared to EHR and panel support tool alone
  - For every 1 million members, 1400 heart attacks and strokes averted annually
- Reduced hospitalizations and costs
  - Estimated $98 million saved annually
Risk of Heart Attack or Stroke over the next 5 years

Risk %

- Healthy
- Stop Meds
- Risk Today
- My Plan
- Statin
- Smoking Cessation
- Asprin
- ACE-Inhibitor
- Calcium Channel Blocker
- Lose Weight

66%
35%
30%
27%
26%
21%
12%

% ... denotes Relative Risk Reduction

IndiGO® (Individualized Guidelines and Outcomes) is intended solely for informational purposes only. It is not intended to replace or otherwise serve as advice from a medical professional. If you have any questions about the information or results presented, seek assistance from your medical professional.
What are the effects of improving HEDIS Scores?

- **Interventions**
  - Simvastatin 40mg for diagnosed hypertensives if not meeting ATPIII targets
  - Simvastatin 40mg to anyone not meeting ATPIII targets
  - Single generic HTN med if systolic > 140
  - Glucose control to HbA1c <7.0

- Modeled improvement on each from average of CA plans to 75%
Assumptions

• Population modeled based on national data (NHANES)

• Event Costs
  • MI or stroke with 5-yr follow-up $65,000 (from Medicare claims data)

• Intervention Costs
  • Lipids and Hypertension
    • $150 (additional labs and visits)
    • Generic meds covered by pt copay
  • Glucose control: undetermined
## Results of Improved Performance

### Annual Impact of targeted improvement in HEDIS Score per Million adults in population

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Increase (%)</th>
<th>Treated</th>
<th>Events Averted</th>
<th>Cost savings ($M)</th>
<th>Net savings ($M)</th>
<th>Savings Per patient ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statin w HTN</td>
<td>12</td>
<td>10231</td>
<td>59</td>
<td>3.8</td>
<td>2.3</td>
<td>225</td>
</tr>
<tr>
<td>Statin (ATPIII)</td>
<td>12</td>
<td>22321</td>
<td>117</td>
<td>7.6</td>
<td>4.2</td>
<td>188</td>
</tr>
<tr>
<td>Hypertension</td>
<td>9</td>
<td>24140</td>
<td>116</td>
<td>7.5</td>
<td>3.9</td>
<td>162</td>
</tr>
</tbody>
</table>

### Conclusions

- Simple preventive measures using generic drugs can be cost effective
- ARCHeS can model the specific impacts of different targets in different subgroups of your population using your cost structure

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Recognition

• IndiGO named “best care app” at Office of the National Coordinator Datapalooza in June 2012

• ONC currently sponsoring Million Hearts Mobile App challenge that features the IndiGO risk engine

• Archimedes awarded an indefinite duration, indefinite quantity (IDIQ) contract by Dept of Health and Human Services for both Arches and IndiGO
  – First and only modeling platform available to all agencies of HHS (e.g. CMMS, FDA, NIH, AHRQ, etc.)
Recent Peer-Reviewed Publications

- Health and economic outcomes for exenatide once weekly, insulin, and pioglitazone therapies in the treatment of type 2 diabetes: a simulation analysis
  [» Vascular Health and Risk Management, Apr 2012]
- Physicians’ Actions And Influence, Such As Aggressive Blood Pressure Control, Greatly Improve The Health Of Diabetes Patients. [» Health Affairs, Jan 2012]
- An Estrogen Model: The Relationship between Body Mass Index, Menopausal Status, Estrogen Replacement Therapy, and Breast Cancer Risk. [» Computational and Mathematical Methods in Medicine, Jan 2012]
- Impact of Comorbidity on Colorectal Cancer Screening Cost-Effectiveness Study in Diabetic Populations [» Journal of Internal General Medicine, Jan 2012]
- Cardiovascular outcomes associated with a new once-weekly GLP-1 receptor agonist vs. traditional therapies for type 2 diabetes: a simulation analysis
  [» Diabetes, Obesity, and Metabolism 9/6/2011]
  [» Annals of Internal Medicine, 5/2/2011 ]
- Health Benefits and Cost-Effectiveness of Primary Genetic Screening for Lynch Syndrome in the General Population. [» Cancer Prevention Research, 11/18/2010]
- Modeling the effects of omalizumab over 5 years among patients with moderate-to-severe persistent allergic asthma. [» Current Medical Research and Opinion, 11/04/2010 ]
- Cost-effectiveness of adding information about common risk alleles to current decision models for breast cancer chemoprevention.[» Journal of Clinical Oncology, 6/07/2010]
- Age at Initiation and Frequency of Screening to Detect Type 2 Diabetes: A Cost-Effectiveness Analysis
  [» The Lancet, 4/30/2010 ] [» View Technical Appendix ]
- Effect of Smoking Cessation Advice on Cardiovascular Disease. [ »American Journal of Medical Quality, 5/01/2009 ]
- The Relationship between Insulin Resistance and Related Metabolic Variables to Coronary Artery Disease: A Mathematical Analysis
  [» Diabetes Care Publish Ahead of Print, 11/18/2008 ]
- A Physiology-Based Mathematical Model of Coronary Heart Disease Accurately Predicts CHD Event Rates in Real Populations. [ »Circulation, 11/08/2008 ]
- Validation of Prediction of Diabetes by Archimedes and Comparison with Other Predicting Models.
  [ »Diabetes Care, 5/28/2008 ]

More at: http://www.archimedesmodel.com/publications
Thank You
Modeling can make a difference

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