May 20th, 4:00 PM

Systems Science and Health: Using Analytical Approaches to Evaluate Healthcare Policy Decisions

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Keywords
systems science, computer simulation, healthcare delivery

Comments
Presented at the 2014 UMass Center for Clinical and Translational Science Research Retreat, held on May 20, 2014 at the University of Massachusetts Medical School, Worcester, Mass.

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Systems Science and Health
Using Analytical Approaches To Evaluate Healthcare Policy Decisions

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SYSTEMS SCIENCE

Shamsnaz Virani, PhD, Systems Engineering and Leadership Institute, WPI
Oleg Pavlov, PhD, Economics and System Dynamics, WPI
What is Systems Science?

- Systems Science is a family of methodologies
  - System Dynamics; Agent Based Modeling; Discrete Event Modeling; Social Network Analysis; Hybrid Modeling
- Enable the study of *complex problems*
- Take a *holistic view*, i.e. models include physiological, economic, behavioral, etc. components
- Allow the *big picture* view of a complex problem, while modeling components of the system
- Based on *computer modeling and simulation*
Systems Science Sims may Include...

- Socioeconomic Perspectives
- Behavioral Perspectives
- Cognition Perspectives
- Integrating Life Course Perspectives
- Institutional Perspectives
- Neighborhood Perspectives
- Health Care Elements
- Effects of Networks
- Big Data
Supplemental Issue: Systems Science Applications in Health Promotion and Public Health

October 2013; 40 (1 suppl)

“Systems Science: A Good Investment for the Public’s Health”
Patricia L. Mabry, PhD, and Robert M. Kaplan, PhD
What is a System?

Health Care Delivery: Patient Experience

National

Local / Regional
“The function of systems engineering is to guide the engineering of complex systems.”

Guide ⇒ Lead, manage, direct ... to show the way

Engineering ⇒ The application of scientific principles to practical ends

System ⇒ A set of interrelated components working together towards a common objective

Complex ⇒ Elements of the system are diverse and tightly coupled
Customer Needs

Requirements Formulation & Analysis

Functional Analysis & Allocation

Verification Loop

Requirements Loop

Architectural Alternatives & Synthesis

Design Loop

Control Loop

Project Boundary

System Analysis & Control (Balance)

Validation Loop

Balanced Product (Performance, Cost, Risk, & Schedule)
USE OF LOW-FIDELITY SYSTEMS FOR HEALTHCARE POLICY DESIGN

Khalid Saeed, PhD, Economics and System Dynamics, WPI
Policy formulation process

Healthcare Delivery Institute

Policy formulation process

- Often buckets of ignorance
- Works in **short run**
- Fails in **long run**
- Cannot be verified
- Aimed at alleviating symptoms

In HIGH FIDELITY MODELS, forecasts of future are created, which cannot be verified. These forecasts are used to formulate policies aimed at alleviating symptoms. However, such policies often fail in the long run.
Pest control
(pests, germs, diseases)
Breakdown repair (healthcare delivery)
How models are used

• Forecasts given by complex instruments determine service budgets.
• Service budgets create allocations for the service.
• Models serve mainly as justification for the budget.
• Problems continue to persist.
Alternative modeling approach (elaborate latent structures)

Visible system

Policies addressing symptoms

Latent system

Policies addressing Root causes
Latent Capacity Support
Example of transforming a forecasting model into a policy tool

- Large complex model created by a consultant.
- Client never understood the model.
- Model output was large array of magical numbers, and a large accompanying bill.
- Use of those numbers in policy was an article of faith
- Our assignments was to make some sense out of it.
Example of transforming a forecasting model into a policy tool

• Model demo
Conclusion

• Use of metaphors in development of models for healthcare delivery can help focus attention to root causes of problems that create policy resilience.
• Low fidelity metaphorical models can help conceptualize high fidelity systems for specific cases
• Use of metaphors can also help to educate public and assist policy actors
• A word of caution: Reductionism is a double edged sword. Recognize its limitations
DISCRETE EVENT SIMULATION

Tze Chiam, PhD, Quantitative Health Sciences, UMMS
UMass Memorial Example 1: Co-locating Clinical Services

• Explore opportunities to co-locate clinical services in order to
  – Improve coordination
  – Improve care
  – Efficiently utilize available footprint
  – Minimize use of resources and maximize outcome

• Discrete-Event Simulation used to evaluate various co-location options
UMass Memorial Example 1: Co-locating Clinical Services
UMass Memorial Example 2:  
Capacity requirements for Observation patients

- Decline of inpatients, increase in Obs patients, decline in reimbursement for Obs
- Obs patients outside of “Obs unit”:  
  - Higher average LOS  
  - Higher cost per case
- “Obs unit” purity compromised due to:  
  - Clinical decisions  
  - Operational decisions  
  - Mis-matched supply and demand
- Discrete-Event Simulation used to study beds requirement
Simulation Results
(41 beds vs 35 beds)
UMass Memorial Example 3: Pediatrics 5E configuration

• Reduction of Pediatrics acute care (5E) footprint from 41 beds to ___ beds
• 5 configurations of single and double beds available
• Due to various isolation needs for pedi patients (age group, clinical reasons, gender, etc), unknown impact due to:
  – Reduced # of beds
  – Each configuration
  – Potential needs to “flex” beds due to fluctuation in volume
Simulation Results (Ave Volume)

Average Monthly Performance Measures based on Ave volume
(4/1/13 to 4/1/14)

- a) 5 singles, 10 doubles
- b) 10 singles, 5 doubles
- c) 7 singles, 7 doubles
- d) 2 singles, 10 doubles
- e) 6 singles, 10 doubles

- Ave bed util
- Average Monthly Performance Measures based on Ave volume
- # flex med surg beds
- # flex PICU beds
- # flex ED obs beds
- # admits off geo
- Ave bed util
FUNDING
Funding: NIH

NIH Budget: ~ $31B

Division of Program Coordination, Planning and Strategic Initiatives

27 Institutes and Centers

Office of Disease Prevention

Sources: http://www.nih.gov/icd/index.html; http://dpcpsi.nih.gov/about
OBSSR functions:

– Funding initiatives for research
– Training and career development for behavioral and social scientists
– Organizes conferences, workshops, and lectures

“We want to aid investigators in using systems science methods to address important public health problems...”
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We are looking for collaborators

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