

Viability Health Systems from Distributed Computing Systems

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**6th Symposium “Understanding Complex Systems”
University of Illinois at Urbana-Champaign
May 15, 2006**



Health Systems

- *Healthcare is THE Societal Issue*
BIGGEST item in modern economies
Fast growing due to aging population
- *Healthcare will BREAK Every Nation*
Nations go bankrupt and People die!



Complex Systems

- *Organizational Problem*

Top-down Central: *Medicine*

Diagnose Diseases and Treatment Cures

- *Technological Solution*

Bottom-up Distributed: *Health*

Measure Features and Cluster Persons



The Fundamental Cause 1

- *Medicine versus Health*

Cure Sick in BIG Hospital

Maintain Wellness in small Clinic

- *Recent Rise of Chronic Illness*

No cure with drugs & surgery

only manage with diet & exercise



The Fundamental Cause 2

- *Health Systems now for Acute Illness*
**Hospitals are Profitable Business but
Clinics are supported by Government**
- *Systems cannot handle Chronic Illness*
**Chronic Illness now dominates Costs
and Systems cannot handle Volume**



Viabile Health Systems

Emergent Properties of Population Health

***No Diagnosis and No Treatment but
Similar People and Similar Progress***

***Viabile Health System is
Adaptive Complex System***



The Viable Solution 1

- *Independent Clinics are Doomed*
1990s America -- small Clinics failed
when Government support reduced.
- *Health Systems start HMOs*
Health Maintenance Organizations
2000s America – HMOs all failing.
2000s Japan – small Clinics will fail
when Government support reduced.



The Viable Solution 2

- *Need Complete Provider Pyramids*

High Level for High Quality at High Cost

Low Level for Low Quality at Low Cost

Handle Volume by Pushing Cases Down

Bottom Levels handle MOST CASES

- *Viable Healthcare Infrastructure*

**Hospitals with Doctors for Surgery, Clinics
with Nurse for Drugs, Homes with Patients
for nearly all Health Interactions!**



Healthcare Infrastructure

- *Infrastructure is the Whole System*
Hospital, Clinic, Home
Doctors, Nurses, Brochures, Internet
- *NO Viable Model for Health System*
Too much Cost! Too Much Volume!



Health Informatics

- *Need New Viable Infrastructure*

Health Information Technology

Provides Support for Patients in Homes

Creates Bottom of Pyramid to Offload

- *Informatics can Solve this Problem*

Patients themselves create population health database via informatics that automatically routes healthcare



Connecting for Health (UK)

National Health Service

HealthSpace

<https://www.healthspace.nhs.uk/index.asp>

- **HealthSpace is a secure place on the internet where you can store all your personal health information. Please use the links below to find out more.**
- [Personal details](#)
- [Health details](#)
Track your health online.
Keep a record of all your [medications](#).
- [Library](#)



Informatics Technologies

- *Measure Population Health*

**Adaptive Question Asking of
Quality of Life Questionnaires**

**Answers for Individuals creates
Database for the Population**

- *Manage Population Health*

**Structured Health Vectors from
normalized patient records**

**Statistical Information Retrieval
cluster patients into care cohorts**



Measure Population Health 1

- *Quality of Life Questionnaires*

Self-Assessment directly by Patients

General Status questions, e.g. SF-36

Specific Disease questions, e.g.

Arthritis: Can you walk without pain?

Heart Disease: Do your ankles swell?

- *QoL correctly does coarse prediction*

VA Heart Study: SF-12 better than surgeon about patient survival



Measure Population Health 2

- *Electronic Records for fine prediction*

Paper supports 10s of questions

Electronic supports 1000s of questions

- *Adaptive Question Asking*

Choose questions by weighted treewalk

Each session asks 10s of questions
customized to particular condition

- *Generate Population Database*

Daily individual records from all homes



Manage Population Health

- *Structured Health Vectors*

Patient answers Questions daily

Average scores generate Health Vector

Elements of Vector are Meaningful

- *Cluster Patient Cohorts*

Normalize Vectors for Similar Clusters

Weight Question Groups Medically

Route Care into Pyramid using

Clusters to Determine Cohorts



Theory Experiment

- *Questionnaire from Merged QoL*
120 questions from 20 questionnaires
General plus some Specific questions
- *Simple Clusters do coarse prediction*
Students simulate sick or well patients
K-means with random seeds does
correct clustering from actual health
monitor sessions with 100 answers



Practice Experiment

- *Practical Risk Assessment Possible?*

**Need 4 Cohort Clusters correctly predicted:
hospital, clinic, telephone, home**

Is 120 questions (10*more) enough?

- *What Clusters can do fine prediction?*

**Use Historical Database of Real Patients
answering Paper QoL Questionnaires**

**Agglomerative with complete link always
consistent but always correct? May need
appropriate structured vector weighting**



Clinical Experiment

