Complex Adaptive Systems and Organizational Learning: Implications for Clinical Decision Support and Knowledge Management

Tonya Hongsermeier, MD MBA
Chief Medical Information Officer
Lahey Health
• Complex adaptive systems – what makes healthcare delivery systems complex and adaptive
• Leadership for effective clinical knowledge management, organizational learning and problem solving in complex adaptive systems
• Governance and cultural considerations for complexity
Complexity is a measure of the number of possible states a system can express.

A Complex Adaptive System is made up of a large number of independent agents that seek to maximize their own goals but operate (adapt) according to rules and incentives in the context of relationships with other independent agents.

Independent agents have the freedom to self-organize, take unpredictable courses of action and can change the context of other agents.

Complex Adaptive Systems (CAS) can be nested to form Complex Adaptive Systems of Systems (CASOS).

Bennet A, Bennet D Organizational Survival in the New World: The Intelligent Complex Adaptive System, Elsevier, Boston, MA 2004
**Simple Linear**  
*Perform Lab Test (Manufacturing)*

- The recipe is essential
- Recipes are tested to assure replicability of later efforts
- Small amount of expertise; knowing how to operate machines increases success
- Procedures produce standard results
- Certainty of same output every time

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**Complicated**  
*Colonoscopy in Low Risk Pt*

- Formulae are critical and necessary
- Models are tested to improve prediction and reliability
- High level of expertise in many specialized fields + coordination
- Low Risk Pts similar in fundamental ways
- High degree of certainty of outcome

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**Complex**  
*Manage Septic Pt (Creating, Adapting)*

- Formulae have only a limited application
- Treating one pt. gives no assurance of success with the next
- Expertise can help but is not sufficient
- Every sepsis unique – “my patient is different”
- Uncertainty of outcome remains

*based on Dr. Sholom Glouberman, McGill University  
http://www.healthandeverything.org/files/INSEAD%20Dec%2006%202006.ppt*
CMS New Rules: If you give us your data, we will hurt you less
• **Diffuse Accountability**
  – *ie: Hospitals and Affiliated Providers in an ACO*
  – *Incentive alignment vs top-down direction*

• **Co-evolution** – Each Agent’s Adaptation Causes “Counter-Adaptive” maneuvers
  – *Payors reimburse for documented data elements, EHR becomes polluted with useless data, Quality is compromised*
  – *Users copy, paste, clone inaccurate data*
  – *EHR and CDS implementation → Unintended consequences*

• **Must Identify the Critical Levers that Catalyze Productive Change.**
  – Even small changes in a CAS can have very large effects. Incentives can be mal-aligned across agents → counterproductive, conflicting behaviors
  – Focus on Outcomes and Accountability
  – Incentives Aligned with Outcomes
  – Measure compliance and performance

*McDaniel, Rouse, Holland (see references on last slide)*
From “Designed to Adapt: Leading Healthcare in Changing Times” by Dr. John W. Kenagy

http://kenagyassociates.com/

- Historically, organizations move data and information up to people in meetings. So leaders gather data and constantly search for the right numbers, the best metrics, then they analyze plan, predict and implement solutions back down into the work place. Data up, implement down.

- In the future highly adaptive organizations, management succeeds not just by gathering more analytics, but also by moving data, problem-solving and decision making close to where the work happens.

- This approach must be integrated with over-riding guiding principles, governance, well-understood institutional values, and project management resources to ensure front-line teams move projects to completion
Intersection of Healthcare Delivery and Clinical Knowledge Management

Guided Data Review

Guided Decisions & Orders

Guided Execution of Decisions & Orders

Guided Assessments & Monitoring of Interventions

Knowledge

Update/Acquire Knowledge, Curate Assets

Identify Gap in Knowledge or Care → CDS Target

Measure Effectiveness Of CDS Knowledge Research & Discovery

Even the best EHRs are not designed as Learning-Ware
• Pay-for-Volume and Accountable Care at the same time

• Individualized, patient-centered medicine and evidence-based standardization

• Regulations that require we advance the use of EHR technologies also make them unusable → Provider burn-out

• It takes lots of “knowledge” to configure EHRs to enable workflow to collect data to feed analytics and support a learning organization

“All we ever talk about anymore is plagues.”
Five Approaches to Clinical Knowledge Management Leadership that build on Complexity Science

1. Collaborative, Non-authoritative leadership – develop your “influencer” style of leadership
2. Humble, Wise CDS – recognize “unknowability”
3. Focus on the Critical Levers and expect that you are never done adapting, ie, never finished curating knowledge
4. Embrace surprises, admire the problems
5. Build resilience and agility through transparency, less hierarchical communication
Collaborative Leadership

• Leverages Relationships and Social Networks
  ❖ One of my mottos: I never gotten anything done because I could tell anyone what to do
  ❖ Nancy Astor: The main dangers in this life are the people who want to change everything... or nothing (the authoritarians)
  ❖ Practice “Influence without Authority” even when you have authority

• Sponsors the people who perform the work to participate in problem solving and innovation

• Web 2.0 technologies are empowering the stakeholders no matter how hierarchical a health system may be
Web 2.0 Collaborative Knowledge Management makes it easier for front-line stakeholders to come together and innovate

- Knowledge Engineers become Social Network Architects
- Curating decision-making and translating those decisions into EHR workflow tools and reporting
Architectures for Participation:
get people out of email inboxes, into collaboration spaces –
builds collective memory and teamwork
Disruptive EHRs will be Collaboration and Learning Platforms

Content Ingestion & Management
- CMS
- curation, versioning, auditing
- Wikis, Blogs, RSS
- Database Management
- Document Management
- Clouds
- Semantics
- Tagging
- Taxonomies/Folksonomies
- Search
- User Profiles/Contacts

Data Management
- Population analytics
- End-user preference analytics
- Best Practice harvesting
- Auto-configuration
- Anticipation
- Learning

Social Interaction Management
- Email/messaging
- Discussion boards
- IM
- Corporate Twitter
- Portals/Virtual Rooms
- Teleconferencing
- Idea Capture
- Expertise Locators
- Social Q&A

Process/Transaction Management
- Rules Engines
- Workflow Engines
- Task Management
- Scheduling/Tracking

Todays EHRs barely do this
Imagine if EHRs could “Learn” how to help Users/Health Systems Self-Improve how to anticipate user workflows and information needs.

Why does Google know more about me than my EHR?

The World Wide Web
- Web 1.0
  - The Desktop PC Era
    - 1980 - 1990
    - Databases
    - Files & Folders
    - Directories
    - Keyword search

The Social Web
- Web 2.0
  - 2000 - 2010
  - Tagging
  - Natural language search
  - User modeling
  - Health System Profiling

The Semantic Web
- Web 3.0
  - 2010 - 2020
  - Automated Content Analysis
  - User profiling

Web 4.0
- The MetaWeb
  - Intelligent Agents Connected Intelligence

EHRs are about here, users can’t find pt. data or knowledge in the swamp.

EHR vendors today impose enormous costs of conversion and curation of Data, Knowledge, Behavior.

**From: Making Sense of the Semantic Web, BY Nova Spivack**
Gaps in Applying Knowledge
  Don’t know you don’t know
  Don’t take the time to know
  Know but still don’t do
  Bias, Diagnostic Momentum

Ignorance of How to Perform What is Known
  ie incompetent at performing a procedure
  Lack of experience

Gaps in Knowledge
  ie forget that antibiotics distort coumadin
  Fail to recognize pattern…

Can’t access information –
  ie: information to interpret test result

Can’t access patient data –
  ie: test results

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Clinical Decision Support Sweet Spot: Knowable Things Important to Remember and Easy to Forget

Inspired by Milan Zeleny – the DIKW pyramid
Choice-oriented CDS Design Strategies

• Choices/preferences influenced by many subtle details of how a clinical decision support offers guidance
• Treat your users like the “knowledge workers” they are, offer smart choices and avoid patronizing hard stops
• Default choice tends to get selected more often

Drive: The Surprising Truth about What Motivates Us Daniel Pink)
Partners-developed CDS approach that no commercial vendor does
Decomposing a “simple” rule into its reusable components:

IF in non-gestational DM pt  with non-ESRD  qualifying for ACEi

Key:
___ AND
... OR

CDS logic that is “smart” is rarely linear or simple
Managerial strategies relevant to CAS: You are never done – So Tackle Manageable Chunks

• Careful not to “boil the ocean”. Perfect, complete solutions risk becoming science projects incapable of solving anyone’s problems

• Tack and Jibe as you implement tactical knowledge-based interventions with trial and error

• Create the context and conditions in which the decision support system can keep evolving with agility to produce desired outcomes

• Take time to understand how your interventions might have created new adaptive behaviors (ie nurses shutting off alarms due to noise overload)

• Respect history, “culture eats strategy for lunch”, killer apps are few and far between
Leaders will often ask you to build something before contemplating how to operationalize it.

### Operationalization

Examples:
- Clinical support staff tee’s up visits and acts on decision support recommendations
- Clinical leadership ensures their staff is accountable to understand the decision support and apply recommendations appropriately to patients
- Review reports to identify opportunities to improve, track progress

### Training and EHR Skills Development

Examples:
- Caregivers and support staff learn new functionality
- Trained how utilize new clinical decision support recommendations
- Trained on how reports can help them see how they are doing
- Integrated training of EHR skills and domain knowledge re: Accountable Care, Clinical Documentation, Coding, Care Plans

### Configuration

Examples:
- New clinical decision support intervention reminds providers assess and code for high-risk patient conditions
- New clinical decision support intervention and reports ensure support staff perform pre-visit planning interventions for accountable care population
- Reports and analytics are configured to enable reporting on compliance and clinical outcomes
When surprises happen in complex adaptive systems where accountability is diffuse, cultures of blame will activate the circular firing squad.

“I love how you play them against each other.”
• Errors in Healthcare are often the result of breakdown on several levels
  – There may be several causes all of which are necessary, but none of which alone are sufficient – James Reason’s Swiss Cheese Model of Human Error
  – You know you are in a complex-adaptive system when errors and surprises result in a circular firing squad of blame – ie “Transition of Care” and “Readmission Prevention”
  – High Reliability Organizations are effective at teamwork, agility, and innovation in the art and science of anticipating and coping with surprise
### Embracing Surprise

<table>
<thead>
<tr>
<th>Interpretation of Event</th>
<th>Opportunity</th>
<th>Threat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unknowable</td>
<td>Innovation</td>
<td>Denial, simplification, control</td>
</tr>
<tr>
<td>Knowable</td>
<td>Learning Experience</td>
<td>Blame, Punishment, etc</td>
</tr>
</tbody>
</table>

*McDaniel RR et al, Surprise, Surprise, Surprise! A Complexity Science View of the Unexpected, Health Care Manage Rev, 2003, 28(3), 266–278*
• Accept that **surprises will happen** – as surprise emerges in a CAS, managers must encourage teams to respond to unanticipated circumstances

• Encourage stakeholders to take agile action as unanticipated consequences unfold, support transparency of communication

• **Hierarchical communication models generally breed mistrust**, miscommunication and confusion with continuous revelations of information non-parity

• Be committed to organizational resilience - encourage a **positive view of unexpected** as an opportunity to innovate, learn, build wisdom
Governance and Healthcare IT

EHR Steering Committee

Clinical Content Governance

EHR Workflow Committee

Strategic IS Workgroups
- Nursing Workflow
- Provider Workflow
- Quality and Safety
- Patient Experience
- Meaningful Use
- ACO/PCMH
- Revenue Cycle/Access

Medical Executive Committee(s)

Clinical Discipline SME Panels
- Medication Safety, Pulmonary, Cardiology, Neurology, Ortho, Hospital Medicine, Gen Surgery, Heme Onc, Etc

EHR Module Workgroups
- Ambulatory, Inpatient, CPOE, ED
- Patient Portal, Access, Financials, Lab, Pharmacy, Radiology
Classic First Order Learning:
Team changes action to create a different result. Does not consider context, reconsider assumptions

Second Order Learning:
Team engages in reflection upon the context to make new problem framing and solution designs possible...

Parting Thoughts

• Maintain humble approaches to perturbing a healthcare organization with Clinical Decision Support and Knowledge Management

• Build Knowledge Management teams, tools and solutions focused on architectures for participation, agility, transparency

• Focus on “low hanging fruit” problems to solve
  – Problems where there strong incentives to solve them
  – Focus CDS on evidence that important to remember, easy to forget,
  – Focus interventions whereby HIT system is likely to have enough information to offer helpful, humble support
War and Peace, by Leo Tolstoy
Book Eleven, Chapter 1

“Only by taking infinitesimally small units for observation (the differential of history, that is, the individual tendencies of men) and attaining to the art of integrating them (that is, finding the sum of these infinitesimals) can we hope to arrive at the laws of history.”

Marcel Proust

“The true journey of discovery does not consist in searching for new territories but in having new eyes.”
• Blackford Middleton
• Jonathan Einbinder
• Roberto Rocha
• Saverio Maviglia
• Scott Finley
• Joe Bormel
• Barry Blumenfeld
• Kevin Fickenscher
• Ida Sims
• Caleb Goodwin
• Isaac Kohane
• Kenneth Mandl
• Ken Kizer
• John W. Kenagy
• Many others mentioned in these slides and in the reading resources
• Malcolm Gladwell: Blink and the Tipping Point
• Dave Logan and John King: Tribal Leadership
• Nicholas Christakis: Connected: The Suprising Power of Our Social Networks
• John W. Kenagy: Designed to Adapt: Leading Healthcare in Challenging Times 2011
• Clayton Christensen: The Innovator’s Prescription: a Disruptive Solution for Health Care 2008
• Daniel Pink: Drive: The Surprising Truth about What Motivates Us 2011
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