Toto, I’ve a feeling we are not in Kansas anymore.
The world is changing.

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The Challenge

Health care is the most complex and confusing system in the world!

Rocket science is not healthcare.
The Healthcare System Is Broken!

- Lack of communication
  - Between clinicians
  - Between clinicians and patients
- Lack of interoperability
- Systems are siloed
- Systems are out of date
- Medical errors are the 2nd leading cause of death
But there is hope for the future!

• Health and healthcare are undergoing more changes and at a faster pace than ever before in history.
Change creates new technology, new initiatives, and new stakeholders who are beginning to recognize that the future requires the use of standards to accomplish goals.

The world is changing at an exponential rate!
TECHNOLOGY …
The primary driver of change

- Computational power & memory size
- World Wide Web and Internet
- Instant communications world-wide
- Smart phones and mobile devices
- Wearable sensors and the Internet of Things
- Cloud computing
- New technologies = new perceptions
Change in focus

• Shift from “sick” care to health
• Shift from fee for service to value based care
• New emphases
  – Precision Medicine
  – Population Health
  – Patient-Centric EHRS
  – Health Information Exchange
  – Creation of Big Data
  – National and Global Registries
How do we introduce these new kinds of data into the workflow and decision making?

Burning Platform: Overwhelming Complexity

- Proteomics and other effector molecules
- Functional Genetics: Gene expression profiles
- Structural Genetics: e.g. SNPs, haplotypes

Sets of Facts per Decision

- Human Cognitive Capacity
- Decisions by Clinical Phenotype


Recalibrating Informatics "True North" | William W. Stead | May 27, 2010 | 2010 AMIA NOWI
New Voices …

• Patients, consumers, citizens or what ever we wish to call them are having an influence in health and health care.

• “Googling” has opened the knowledge and understanding of disease for the non-professional to change the communication between physician and patient.

• Shifting care outside traditional settings
• Data collected and analyzed in real time becomes more responsive.
• Patients want to push this data back into their EHR.
Mobile Devices

- The ubiquity of smart phones has changed communications between and among groups. A virtual visit will replace an office visit.
- Wearable sensors will give real time data about the person resulting in early interventions.
- Smart phone apps can be used for data collection by text, check boxes, and photographs with sufficient resolution to make clinical diagnoses in many areas such as dermatology.
- Smart phones can be used for education, behavior modification, and more.

Brick and mortar institutions will be replaced by virtual healthcare systems.
Today everything is a source of data

REQUIRES
- Data Liquidity
- Data Sharing
- Data Standards
Big Data and Its Impact

• Big Data is a consequence of more things that create data and more initiatives to merge data.
• For a single patient, we are talking about petabytes of data; for a aggregated database of multiple patients, we are talking about exabytes or more.
• Computable knowledge is an award of Big Data.
• Requires new and innovative methods of analyses to create new knowledge
• NoSQL databases making their appearances to provide higher speed necessary for analyses.
  – Hadoop, mongoDB, others
Decision Making

• The amount of data and the kinds of data influencing health and health care has far exceeded the ability of the human brain to make fact based decisions.

• Therefore, decisions will be made by computers and executed directly without human engagement.
The Second Machine Age

- Cognitive Computing
- Machine Learning
- Deep Learning
- Artificial Intelligence

Everybody’s doing it
- Google
- IBM
- Apple
- Microsoft
- Amazon
- Haven
- Others
Artificial Intelligence and Robots

Google’s AI Creates Its Own AI That Beats The Performance Of Other Human-made Models
Multiple roles

- Counselors
- Educators
- Companions
- Caregivers
- Others

Sophia

Robbie

Tomorrow’s Nurse
Enabling standards

- HL7 FHIR ®
- SMART ®
- CDS Hooks

REST (REpresentational State Transfer)

OAuth 2.0

“Give me a place to stand, and a lever long enough, and I will move the world.”
— Archimedes
Resources

• Resources are:
  – Small logically discrete units of exchange
  – Defined behavior and meaning
  – Known identity and location
  – Resources refer to each other using URLs
  – Smallest unit of transaction
Extensions

- FHIR has a standard framework for extensions
- Every FHIR element can be extended
- Every extension has
  - Reference to a computable definition
  - Value - from a set of known types
- Supports local requirements
- Reusable
Profiles

- Resources are combined into “Profiles” to solve clinical and administrative problems in a practical way.
  - Parties exchanging data define the specific way they want to use resources and their relations using Profiles.
  - Profiles are the framework for defining services.
Profiles

• Document constraints and extensions on one or more resources
• Subsumes template, implementation profile, detailed clinical model, etc.
• Defines the collection of resources to accomplish a given task such as register a patient
REST: The Essence of FHIR

REpresentational STate

Google, Twitter, Facebook

Your favorite travel site
REpresentational State Transfer (REST)

• An architecture for how to connect systems
• Operations
  – Create – create a new instance of data
  – Read – get the content of an instance of data
  – Update – change the content of an instance of data
  – Delete – remove the instance of data
SMART ®

- SMART = “Substitutional Medical Applications and Reusable Technology”
- A SMART App is a Web App
  - HTML5 + JavaScript
  - Typically embedded in EHR
  - EHR Data Access is via FHIR
- Supports smart-phone and patient controlled apps
SMART ®

• Enables vendors to create apps that seamlessly and securely run across healthcare systems
• Defines a health data layer that builds on FHIR and resource definitions
• Applies set of profiles used to express meds, problems, labs and other clinical data
• Patients, clinicians, others can draw on library of apps to improve clinical care, research, and public health
CDS Hooks

• CDS Services
  – Provides a service that is invoked by the EHR via a hook
  – Evaluates its own logic using FHIR data
  – Returns decision support via cards
Bulk Data on FHIR

• The technology & policy for exchanging records from an unlimited number of patients or study subjects
• Developed cooperatively with Boston Children’s Hospital / Harvard
• Supports data analytics for population health, value-based care, clinical trial design and pharmaco-vigilance.
After interoperability FHIR is the gateway for AI

Once the specification gains wider use for data exchange, it will open the doors for more advanced uses of data, including artificial intelligence and machine learning, IBM, Google and Microsoft executives said at HIMSS19.

By Tom Sullivan
February 14, 2019
04:10 PM

Proposed ONC rule requires FHIR interoperability standard

By
Greg Slabodkin

Published
February 12, 2019, 5:44pm EST

If the Office of the National Coordinator for Health IT has its way, HL7’s Fast Healthcare Interoperability Resources will be the standard to which developers must certify their application programming interfaces.

In ONC’s proposed rule, released on Monday, the agency for the first time has said that it intends to make FHIR a requirement.

Congress required developers participating in the ONC Health IT Certification Program to publish APIs allowing healthcare data to be accessed, exchanged
Sync4Science & Sync4Genes use FHIR to enable Genomic Data for Precision Medicine & Translational Science
Fundamental Theorem

Source: Charles Friedman, UMich
Problems to solve

• Patient matching – universal patient identifiers
• Common language – global acceptance; everybody in; everybody use
• Increased data quality and trust
• Learning Health
• Increased Clinical Decision Support
• FHIR must support the right data for the right patient at the right time for the right reason.
New Disruptive Innovation Requirements

- More sophisticated use of decision support
- Integration of images and enhanced use
- Biomarkers and genomics
- Social determinants of health
- Automation of Clinical Research
- Partnered iAPPs to tell a complete story
A glance at the future

• Today’s surgeons use 2D images taken by X-ray, ultrasound and MRI for surgical planning. These images may not reveal complex internal structures and complications in the heart’s chambers.

• In a new project, surgeons use 3D printed hearts to plan for difficult surgeries for patients born with complicated heart disorders. The heart models were created using the X3D Open ISO Standard.
On the screen he displays some stunning 3D models of the girls’ skin, skulls and interlocked brains that have been made from traditional scans. "It allows us to try out different strategies for operating, and the likely danger areas given the twins’ unique anatomical structures."

But these computer models don’t just stay on a screen, they can also take on a physical shape thanks to a 3D printer.

"To be able to see and visualize this and play with these models before the surgery makes an enormous difference to how we plan and do this operation," says Jeelani. “What we need to achieve is, in effect, to sort of untwist the brains. And that's pretty difficult to do just in your head."

“This is clearly the way of the future,” he enthuses. “We are blessed here [at GOSH] in terms of the engineers and the software specialists - the skill sets they bring to the equation are skills that we as doctors with our medical training don't have.”
Possible applications for 3D modeling

- Virtual visits
- Surgical scheduling
- Family tree
- Drug structures
- Genomic structures
- Clinical support
  - Exercise physiology involving respiratory system, cardiovascular system, muscular system
  - Organ models
- Patient support
  - Mental health
  - Orthopedics
  - Behavior modification
  - Fall prevention
  - Aging
  - Consent for research – showing what is proposed
  - Consent for surgery – showing surgery
  - Pain management
- GIS
The art of the future possible

- The volume of data, the variety of data types, the increasing wealth of knowledge, and the ability to track disease and co-morbidities from start to finish will overpower the ability of humans to make informed decisions about health and health care.
- Computers will not only become the decision makers but will carry out the decisions directly.
- The role of the human clinician will change to being an interface between computers and patients, and that may only be a temporary step.
- Most humans will be replaced in healthcare systems.
- To resist is futile.