Contemporary EHRs: How Standards Support Global Research and Education

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Mark Genuis, PhD, ICE Health Systems
Agenda

• Introductions
• The Big Picture about Data and EHRs (Spallek)
• ICDAS/ICCNS (Gonzalez-Cabezas)
• Caries Standards in Action (Genuis)
• Discussion
Collaboration for Health IT
Disclosures

**Johnson**
- No financial compensation
- COI/COC files with U-M

**Spallek**
- No financial compensation
- Unrestricted travel support to attend ADEA/AADR/IADR in 2017 & 2018
- Outside Earnings Declaration filed with Usyd

**Gonzalez-Cabezas**
- No financial compensation

**Genuis**
- CEO of ICE Health Systems
The Big Picture about Data and EHRs

Heiko Spallek, PhD, DMD, MSBA, University of Sydney
Dentists Trust Dentists

adapted from @David // Armano darmano.typepad.com
The Big Picture about Data and EHRs

Heiko Spallek, PhD, DMD, MSBA, University of Sydney

Ideas

Opportunities of Big Data
Trends in HIT
Requirements for AI in Healthcare
Patient Portals
EHR as Barrier
Power of Standards: e.g. SNODDS
Learning Health System
1854: What can we discover from data?

“Broad Street Cholera Outbreak”
164 Years Fast Forward: Trends in Health IT

- Interoperability
- Blockchain
- Artificial Intelligence

“There is palpable excitement at the interface of biology, psychology, engineering, sensor technology, computation and therapeutics”

Dr. Jeffrey Flier, Dean of the Harvard Medical School


What can be done with Big Data?

By integrating claims, clinical, socio-demographic and care management data, you receive both a retrospective and prospective view of your patients and your patient populations.

- Clinical data of nearly 50 MILLION PATIENTS
- Longitudinal claims data of 20 YEARS
- Claims data covering over 109 MILLION LIVES
- Identify at-risk patients earlier
- Preserve patient health
- Reduce costs
- Prevent complications

Mayo Clinic (59,000 employees) + UnitedHealth Group ($122 billion corporation) + Optum Labs:

$300m research study over 5 years:
repeated in hours, same result
Progress in AI accelerates because:

- Frustration with the existing systems
- Ubiquity of networked smart devices
- Comfort with at-home services

“without access to high quality, reliable data, the promise of AI will not be realized”
JASON Recommendations

- Capturing smartphone data
- Integrating social and environmental data

Artificial Intelligence for Health and Health Care
JSR-17-Task-002
JASON, The MITRE Corporation

https://www.healthit.gov/sites/default/files/jsr-17-task-002_aiforhealthandhealthcare12122017.pdf
JASON: Critical Missing Data Gaps

“AI application development requires training data, and will perform poorly when significant data streams are absent.”

What do we collect and aggregate in dentistry?

- Scale?
- Quality?
- Social and environmental data?
- Biospecimen?
- Standardization?
Data Availability in an HIT Ecosystem

FAIR: Findability, Accessibility, Interoperability, Reusability


Potential data sources for HIT ecosystem

• Electronic Health Records, including electronic medical and dental records, genetic data, proteomics data, microbiome data, bio-specimen data, etc.
• Registry data across multiple disciplines
• Patient-generated heath data (PGHD), e.g. home monitoring, seamless integration of PGHD into EHR
• Precision medicine
• Diagnostics
• Socio-economic data (e.g. Census)
• Urban planning data
• Traffic data
• Sensor data
• Health Insurances (claims data)
• Public Health data (surveys)
• Environmental data (workplace, bio surveillance, air quality data, UV radiation, Radon, water fluoridation)
• Education data, including health behaviour interventions in schools and communities
• Dietary data, food consumption, supplements
What data can we collect?

Classes of data
1. structured in traditional databases
2. unstructured, e.g. images, video, voice, GIS
3. Internet of Things (IoT)

https://www.apple.com/researchkit/

https://www.apple.com/healthcare/
Internet of Medical Things (IoMT)
Internet of Dental Things (IoDT)

WORLD’S FIRST CONNECTED ELECTRIC TOOTHBRUSH W/ 3D MOTION SENSORS

Data gets pushed via Bluetooth®
Data = Asset?

- Digital data generated globally in 2002: 5 terabytes
- 5 terabytes now generated every two days
- 90% of the world’s information generated in just the past two years

- Upward trend in data generation
- < 5% of useful data is analyzed to generate information & derive knowledge

Data is a strategic asset with great potential and should be treated and managed as such.

Data Availability and Use: Productivity Commission Inquiry Report, No. 82, 31 March 2017,
Analyzing qualitative data

- Qualitative data = hows & whys
- Transform qualitative -> quantitative: shallow shadow of original form, e.g., toothache
- Humans explain context when communicating
- Computers get context during design from engineers
Patient Portals
e.g., Australia
Welcome to My Health Record

My Health Record is a secure online summary of your health information. You can control what goes into it, and who is allowed to access it. You can choose to share your health information with your doctors, hospitals and other healthcare providers.

Other questions you might have:
- Find out about the [benefits of having a record](#)
- Visit our [frequently asked questions](#)
- Learn more about [privacy and security](#)
- Find out what’s new
- View the [latest My Health Record statistics](#)

[Register or access a My Health Record](#)
EHRs as a Barrier
Electronic Health Records (EHR)

What EHRs Do Right

• Billing
• Legibility
• Availability
• Result reporting
• Order entry
• Alerts and reminders

What EHRs Do Wrong

• Alerts and reminders (alert fatigue)
• Data entry (tedious, redundant)
• Incompleteness
• Data overload (note bloat)
• Poor navigability

Dental Records:

WORN—write once read never
Electronic Medical Record (EMR)  
Electronic Dental Record (EDR)

Integration for
- Safe and efficient patient care, e.g. allergies, medication
- Health profession education based on interprofessional education principles
- Biomedical research that acknowledges that the mouth is part of the body

*If you want to bring healthy lives and healthy mouths together, you also need to bring EMRs and EDRs together!*

Sample research questions
- Is maintaining a full dentition important for older patient?
- Does pre-chemo dental therapy help?
- What role does the dentition play in dialysis outcomes?
- Does a healthy dentition improve overall health?
Standards
e.g., SNODDS
Credit for next slides:

Elsbeth Kalenderian, DDS, MPH, PhD
Chair, Department of Preventive and Restorative Dental Sciences
Leland A. & Gladys K. Barber Distinguished Professor in Dentistry
University of California, San Francisco, School of Dentistry
San Francisco, CA

Visiting Professor
Harvard School of Dental Medicine
Boston, MA
Diagram:

1. Diagnosis
   - Signs & Symptoms
   - Chief Complaint
   - Problems, Findings, Conditions
   - Tests
   - Clinical Exam

2. Risks, Benefits, Costs, Alternatives

3. Prevention
   - No Treatment
   - Minimally Invasive Tx 1
   - Tx2
   - Tx3
   - Tx4
Need for Structured/Standardized Diagnoses

Updated Med Hx (yes/no): yes healthy

Patient Concerns: her perio disease is not stable since her front teeth are loose making her fearful of biting hard. She needs a good quality office where she can put her trust in.

Objective: comprehensive exam wanted to also do a perio maint appoint, but patient did not have any money to spare today and wanted to do this next week. Denise wanted to do the maint today and get her on the road to stabilizing.

OCS: wnl smoker and Dr. A is rec a vizelite exam once a year. Patient scared of the unknown and cried.

GINGIVA: Patient had 4 quadrants of periodontal surgery 2 years ago. She never wants to have it again. molars are inflamed and need attention to help her stabilize. Recession and mobility are generalized.

PROBE DEPTHS: 1-6 mm active infection in the molars perio type 4 at age 30. Bone loss horizontal and vertical.

B.I.:34 sites of bleeding

PLAQUE/CALCULUS: stain al over from smoking and coffee. While probing I could feel debris and rough root surfaces.

RADIOGRAPHS: brought x-rays

DIAGNODENT READINGS: 1=34, 2=17, 5=30, 7=20, 11=12, 12=11, 17=20, 20=9, 21=5, 29=24, 32=28

HYGIENE Tx: needs a perio maint appoint asap

SELF-CARE: uses oral b sonic, floss, picks that resemble a tooth pick, and listerine

RECOMMENDATIONS: stop listerine. She feels her mouth is dry, and she smokes. Gave her 4 choices of rinses. Needs a new home routine. Gave a demo on tooth brushing and go betweens. Which fit everywhere. At PM we will start on fluoride. May do a vizelite exam if patient agrees to it.

DR. EXAM COMMENTS (Prognosis): Patient has periodontal disease. She had perio surgery in the past and she wasn’t very happy with the experience. She was suggested to see an orthodontist about straightening her teeth but she was not sure if that was the best way to go considering her perio condition. She indicated that periodontal disease does run in her family. She admitted that when she was younger hygiene was not adequate and that was because she said that she did not know how to care for her teeth. She also is a regular smoker for many years and she currently is smoking 5 cigarettes a day. She also is an everyday coffee drinker. Explained that she would consult specialist, perio and ortho, in regards to her condition. Once her records are studied and research she will be provided with a consultation. Restoratively she has teeth with old amalgam: #18 will need an onlay, #14 is holding up, #70 ML had recurrent decay and will need to be replaced. GAA

Assessment: Perio maint asap with home care.
Integrated Terminologies Promote Quality of Care
• Created in 2009

• Developed by dentists, informatics experts, researchers and academics from Harvard, UCSF, UT Houston and ACTA

• $7+ million US government funded grant

• Implemented at 22+ American and European dental institutions

• Harmonized with ADA’s SNODENT into SNODDS
Evaluating a Dental Diagnostic Terminology in an Electronic Health Record

Ram Vaderhobli, B.D.S., M.S.; Muhammad F. Walji, Ph.D. Abstract: Standardized treatment procedure codes and

Assessing Use of a Standardized Dental Diagnostic Terminology in an Electronic Health Record

Kalenderian, D.D.S., M.P.H. Abstract: Although standardized terminologies such as the International Classification of Diseases

The Development of a Dental Diagnostic Terminology

Muhammad F. Walji, Ph.D.
Vision of a Learning Health System
Health systems--at any level of scale--become learning systems when they can, continuously and routinely, study and improve them.
A Health System That Can Learn

• Every patient’s characteristics and experience are available for study

• Best practice knowledge is immediately available to support decisions

• Improvement is continuous through ongoing study

• This happens routinely, economically and almost invisibly

• All of this is part of the culture
How can we accelerate 17 years to 17 months? Converting data cemeteries to sources of knowledge
Deliberate and evolutionary process of infrastructure co-production in which the full spectrum of stakeholders are directly engaged.

Purposefully collected data outside of care experience can be important components of the learning process.

Friedman, Rubin, Sullivan: Toward an Information Infrastructure for Global Health Improvement, IMIA May 2017:
https://imia.schattauer.de/en/contents/archive/issue/special/manuscript/27496.html
Atul Gawande on the potential of information for health

kinds of information that matter to your health and well-being over time, information about the state of ... 
- your internal systems, e.g. imaging, lab-test results
- your living conditions, e.g. housing, environment
- the care you receive, e.g. medications, treatments
- your behaviors, e.g. sleep, exercise

“The potential of this information is so enormous it is almost scary.”

What patient care experiences have you encountered that might have been improved if care providers or patients had had access to an EHR that used standards to integrate data from other health care systems?
Dental Caries Records as an Example

Carlos Gonzalez-Cabezas, DDS, MSD, PhD
University of Michigan
Dental Caries
Clinical Decision Making

• Treat the Disease (dental caries): detect lesions, diagnose activity, identify etiologic factors, identify risk, treat, evaluate

• Treat the consequences of the disease (e.g., cavities)
Terminology:

International Consensus Workshop-Caries Clinical Trials Consensus Statements

The consensus was to separate out three key terms:

• Lesion detection
• Lesion assessment
• Caries diagnosis
# ICDAS

**International Caries Detection and Assessment System**

<table>
<thead>
<tr>
<th>Appearance of Occlusal Surfaces (Pit and Fissure)</th>
<th>ICDAS 0</th>
<th>ICDAS 1</th>
<th>ICDAS 2</th>
<th>ICDAS 3</th>
<th>ICDAS 4</th>
<th>ICDAS 5</th>
<th>ICDAS 6</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
<td><img src="image4.png" alt="Image" /></td>
<td><img src="image5.png" alt="Image" /></td>
<td><img src="image6.png" alt="Image" /></td>
<td><img src="image7.png" alt="Image" /></td>
<td><img src="image8.png" alt="Image" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Accessible Smooth Surfaces, Including Cervical and Root</th>
<th>ICDAS 0</th>
<th>ICDAS 1</th>
<th>ICDAS 2</th>
<th>ICDAS 3</th>
<th>ICDAS 4</th>
<th>ICDAS 5</th>
<th>ICDAS 6</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image9.png" alt="Image" /></td>
<td><img src="image10.png" alt="Image" /></td>
<td><img src="image11.png" alt="Image" /></td>
<td><img src="image12.png" alt="Image" /></td>
<td><img src="image13.png" alt="Image" /></td>
<td><img src="image14.png" alt="Image" /></td>
<td><img src="image15.png" alt="Image" /></td>
<td><img src="image16.png" alt="Image" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Radiographic Presentation of the Approximal Surface</th>
<th>ICDAS 0</th>
<th>ICDAS 1</th>
<th>ICDAS 2</th>
<th>ICDAS 3</th>
<th>ICDAS 4</th>
<th>ICDAS 5</th>
<th>ICDAS 6</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image17.png" alt="Image" /></td>
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<td><img src="image19.png" alt="Image" /></td>
<td><img src="image20.png" alt="Image" /></td>
<td><img src="image21.png" alt="Image" /></td>
<td><img src="image22.png" alt="Image" /></td>
<td><img src="image23.png" alt="Image" /></td>
<td><img src="image24.png" alt="Image" /></td>
</tr>
</tbody>
</table>

- **ICDAS 0**: No radiolucency
- **E0 or RO**: Radiolucency may extend to the dentinoenamel junction or outer one-third of the dentin. Note: radiographs are not reliable for mild occlusal lesions.
- **E1 or RA1**: Radiolucency extends into the middle one-third of the dentin.
- **E2 or RA2**: Radiolucency extends into the inner one-third of the dentin.
- **D1 or RA3**: Radiolucency extends into the middle one-third of the dentin.
- **D2 or RB4**: Radiolucency extends into the inner one-third of the dentin.
- **D3 or RC5**: Radiolucency extends into the inner one-third of the dentin.
The Evidence Base in Caries Detection and Assessment

Reliable inclusion of clinical visual enamel & dentine caries detection is not new

• Backer Dirks 1951 >
• Marthaler 1966 >
• WHO 1979
• Pitts & Fyffe 1988
• Ismail 1992
• Ekstrand, Ricketts & Kidd 98
• Fyffe et al 2000
• Nyvad 2001
• And many, many more (see Systematic Reviews NIH CDC and ICW-CCT)
### ADA Caries Classification System

<table>
<thead>
<tr>
<th>Clinical Presentation</th>
<th>Sound</th>
<th>Initial</th>
<th>Moderate</th>
<th>Advanced</th>
</tr>
</thead>
<tbody>
<tr>
<td>No clinically detectable lesion. Dental hard tissue appears normal in color, translucency, and gloss.</td>
<td>Earliest clinically detectable lesion compatible with mild demineralization. Lesion limited to enamel or to shallow demineralization of cementum/dentin. Mildest forms are detectable only after drying. When established and active, lesions may be white or brown and enamel has lost its normal gloss.</td>
<td>Visible signs of enamel breakdown or signs the dentin is moderately demineralized.</td>
<td>Enamel is fully cavitated and dentin is exposed. Dentin lesion is deeply/severely demineralized.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Other Labels</th>
<th>Infected Dentin</th>
<th>Appearance of Occusal Surfaces (Pit and Fissure)</th>
<th>Accessible Smooth Surfaces, Including Cervical and Root</th>
<th>Radiographic Presentation of the Approximal Surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>No surface change or adequately restored</td>
<td>None</td>
<td>ICDAS 0</td>
<td>E0 or RO No radiolucency</td>
<td>E0 or RO*</td>
</tr>
<tr>
<td>Visually noncavitated</td>
<td>Unlikely</td>
<td>ICDAS 1</td>
<td>E1 or RA1* Radiolucency may extend to the dentinoenamel junction or outer one-third of the dentin. Note: radiographs are not reliable for mild occlusal lesions.</td>
<td>E1 or RA1*</td>
</tr>
<tr>
<td>Established, early cavitated, shallow cavitation, microcavitation</td>
<td>Possible</td>
<td>ICDAS 2</td>
<td>E2 or RA2*</td>
<td>E2 or RA2*</td>
</tr>
<tr>
<td>Spread/disseminated, late cavitated, deep cavitation</td>
<td>Present</td>
<td>ICDAS 3</td>
<td>D1 or RA3*</td>
<td>D1 or RA3*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ICDAS 4</td>
<td>D2* or RB4* Radiolucency extends into the middle one-third of the dentin</td>
<td>D2* or RB4*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ICDAS 5</td>
<td>D3* or RC5* Radiolucency extends into the inner one-third of the dentin</td>
<td>D3* or RC5*</td>
</tr>
</tbody>
</table>
The International Caries Classification and Management System is a health outcomes focused system that aims to maintain health and preserve tooth structure. It uses a simple form of the ICDAS Caries Classification model to stage caries severity and assess lesion activity in order to derive an appropriate, personalised, preventively based, risk-adjusted, tooth preserving Management Plan.
Caries Standards in Action

Mark Genuis, PhD, ICE Health System
Adhering to & Encouraging Standards

SNO DDS
Dental Diagnostic System

ICDAS FOUNDATION
International Caries Detection & Assessment System

ISO 27001

SAMLS
Security Assertion Markup Language

HL7® FHIR®

JSON
JavaScript Object Notation
ECMA 262, 3rd edition

ADA American Dental Association®
America’s leading advocate for oral health

ICH
tiatative involving both regulators and research-based industry representatives of the EU, Japan and the US in scientific and technical discussions of the testing procedures required to assess and ensure the safety, quality and efficacy of medicines.

What is ICH?
Integrations

Glick Medical Support System

...And more to come...
How can the ICE Health EHR improve caries research and subsequently patient care?
What CARIES patient care experiences have you encountered that might have been improved if care providers or patients had had access to an EHR that used standards to integrate data from other health care systems?
What standards could help you in your research? How might it help?
Contemporary EHRs: How Standards Support Global Research and Education

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