

The Clinical Impact of Clinical Informatics

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Ode to a former teacher and mentor



The clinical impact of clinical informatics

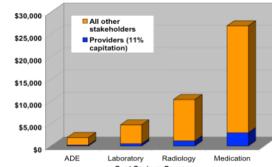
- Questions to ask
 - How did we get here?
 - Where are we now?
 - What does the future portend?
- Disclosure – Research support from Alnylam Pharmaceuticals (not discussed in this talk)

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What a difference a decade makes – era of healthcare improvement

- Safety
 - IOM “errors report” documented 48-96K deaths per year due to medical errors (Kohn, 2000)
- Quality
 - Patients receive appropriate care only 55% of time (McGlynn, 2003)
- Access to information
 - Physicians unable to access known information about patients in 44% of ambulatory visits (Smith, 2005)
- Cost
 - Not only does US have highest costs, but
 - Electronic health records (EHRs) cost-effective overall, but benefits not accruing to those investing (Johnston, 2003)
 - Widespread interoperable EHRs could save \$77B per year (Hillestad, 2005)
- Opportunities for the “tribes” of healthcare improvement (McKethan, 2010)

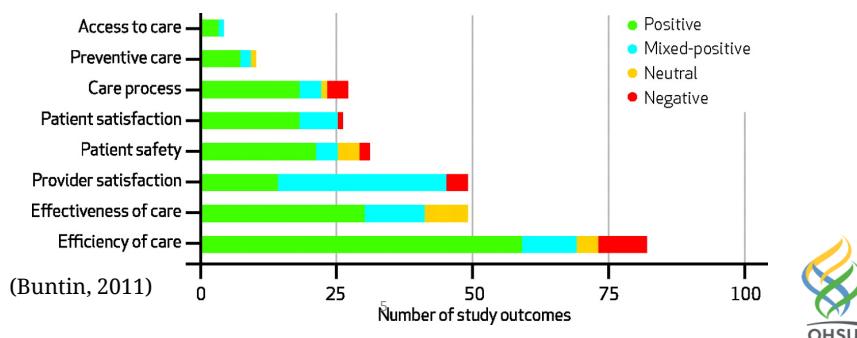


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Based on evidence that information interventions part of solution

- Systematic reviews (Chaudhry, 2006; Goldzweig, 2009; Buntin, 2011)
 - Identified benefits in variety of areas, although
 - Quality of many studies suboptimal
 - Large number of early studies came from a small number of “health IT leader” institutions



And then a perfect storm of recession and healthcare reform



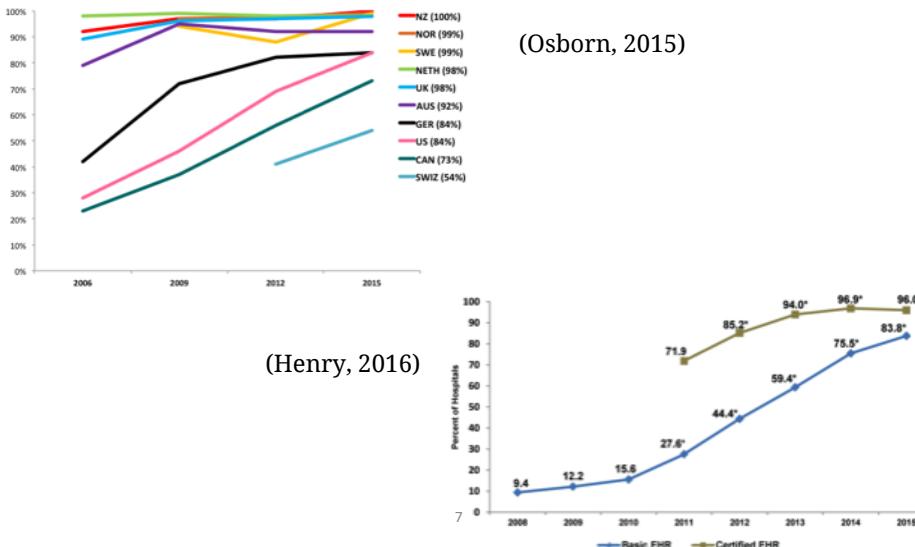
To improve the quality of our health care while lowering its cost, we will make the immediate investments necessary to ensure that within five years, all of America's medical records are computerized ... It just won't save billions of dollars and thousands of jobs – it will save lives by reducing the deadly but preventable medical errors that pervade our health care system."

January 5, 2009

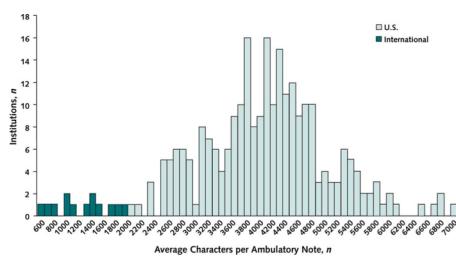
American Recovery and Reinvestment Act (ARRA) allocated \$30 billion in incentives for adoption of EHRs



Leading us to where we are now



But not without challenges



Are there still promises for clinical informatics?

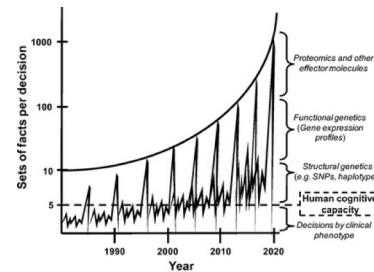
- Yes!
- Machine learning and artificial intelligence
- Clinical data interoperability
- Opportunities for physicians (and others) in clinical informatics

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Medicine is increasingly (and maybe always has been) a “data science”

- Clinicians cannot keep up
 - Average of 75 clinical trials and 11 systematic reviews published each day (Bastian, 2010)
- Data points per clinical decision increasing (Stead, 2011)
- “Precision medicine”
 - Requires management and use of large quantities of data (Collins, 2015; Parikh, 2017)



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1.1b

Role of machine learning and artificial intelligence

- Data science
 - “The science of learning from data; it studies the methods involved in the analysis and processing of data and proposes technology to improve methods in an evidence-based manner” (Donoho, 2017)
- Machine learning (ML)
 - Ability of computer programs to learn without being explicitly programmed (McCarthy, 1990)
- Neural networks
 - Current most successful approaches for ML
 - When use deep layers, called deep learning (Miotto, 2017; Esteva, 2019)
- Artificial intelligence (AI)
 - Older term referring to information systems and algorithms capable of performing tasks associated with human intelligence (Maddox, 2018; Topol, 2019)

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First era of AI was mostly a failure

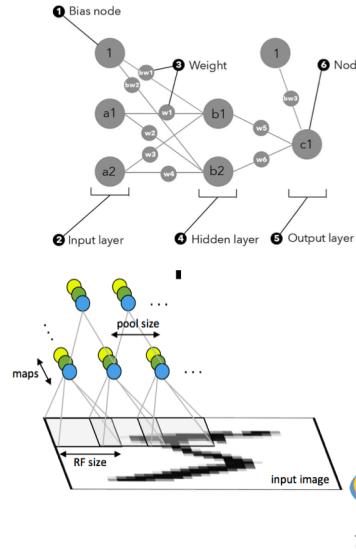
- Focus on human-engineered “knowledge bases” and algorithms to provide “artificial intelligence”
- Origin of field attributed to Ledley and Lusted (1959)
 - Diagnosis via symbolic logic and probability
- Led to “expert systems”
 - Computer programs mimicking human expertise
 - Rule-based, e.g., MYCIN (Shortliffe, 1975)
 - Disease profiles and scoring algorithms, e.g., INTERNIST-1 (Miller, 1982) and DxPlain (Barnett, 1987)
- “Demise of the Greek Oracle” (Miller, 1990)
 - Evolution to more focused clinical decision support in 1990s and beyond (Greenes, 2014)

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Modern era of success comes from neural networks and deep learning

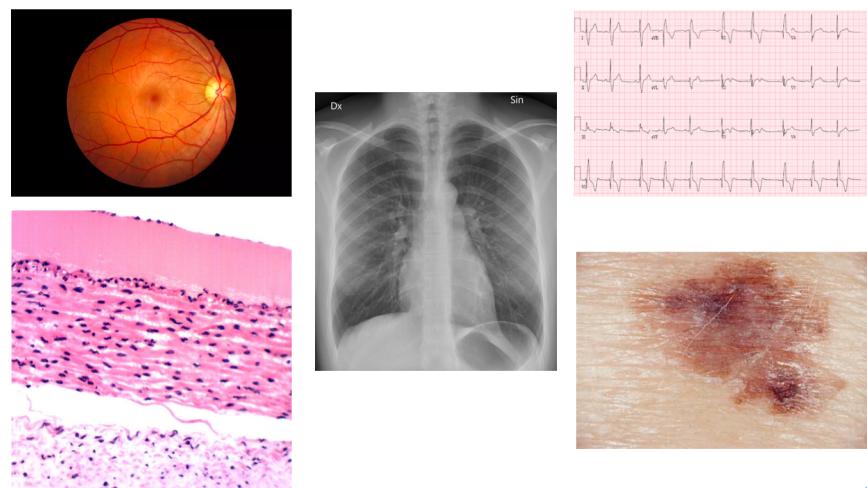
- Aided by large amounts of data and increased modern computing power (Taylor, 2017; Esteva, 2019)
 - Particular success has been achieved with deep learning (Goodfellow, 2016)
 - Neural networks had been around for many decades, but deep learning successes often attributed to work of Hinton (2006)
- Mathematics complex, but can understand what they do in context of ML tasks



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Most success (so far) in imaging and waveform (patterns)

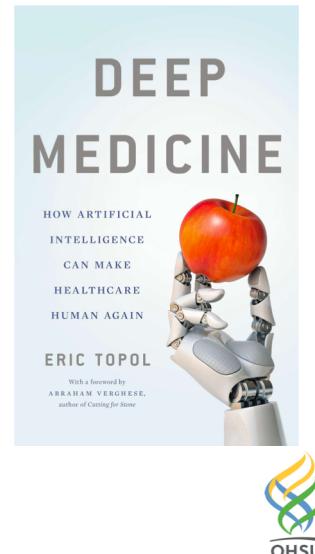


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Put in proper perspective by @EricTopol

- (Nature Med, 2019; Deep Medicine, 2019)
- Impact so far with patterns but other opportunities
 - Clinicians improving workflow and the potential for reducing medical errors, e.g., Rajmokar, 2019
 - Patients enabled to process their own data to promote health
- Current limitations
 - Prospective studies
 - Privacy and security
 - Lack of transparency
- Deep learning, if used properly, may return empathy to medicine?



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Evaluation and regulation of ML and AI in medicine (Parikh, 2019)

- Meaningful endpoints
 - Demonstration of benefit
- Appropriate benchmarks
 - Evaluation in real-world use
- Interoperable and generalizable
 - Transportable to other settings and systems
- Specified interventions
 - Tied to an intervention
- Audit mechanisms
 - Monitored after implementation
- Promise and protection
 - Legal and ethical monitoring



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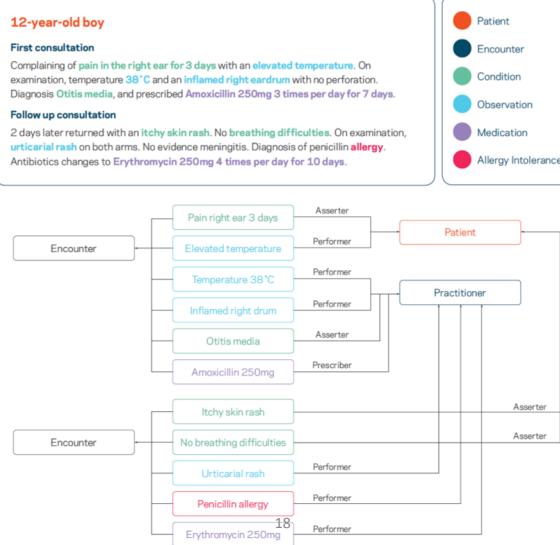
Another shortcoming of HITECH is poor interoperability

- Many re-uses (or secondary uses) of EHR data not primarily collected for research (Safran, 2007)
 - “Computational” re-uses of data require standardized data and terminology
- Emergence of new standard
 - Fast Healthcare Interoperability Resources (FHIR)
 - <http://hl7.org/fhir/>
- 21st Century Cures Act
 - “Correction” of interoperability and other EHR improvements (Mandl, 2017)

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From patient story to FHIR Resources (Hay, 2016)



Substitutable Medical Apps, reusable technologies (SMART)

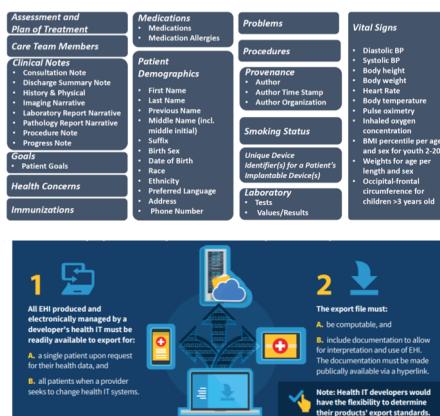
- Based on paradigm of “apps” accessing a common data store (Mandl, 2015)
- Initial uptake modest but took off when combined with FHIR (Mandel, 2016)
 - SMART on FHIR – <https://smarthealthit.org/>
- New paradigm of EHR as “operating systems” with apps on top?

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Getting new push in 21st Century Cures Act

- “Net Neutrality for Health Data” (Jeff Smith, AMIA)
- EHR certification will require
 - FHIR-based access to all data elements
 - Open APIs
 - Easy export of data for patients and systems
 - No gag clauses or information blocking



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Central role of patient

- Personal health record (PHR) – patient view of their record
 - Not a new idea (Shenkin, 1973)
- Expanding beyond data with Open Notes (Delbanco, 2012)
- Mobile devices tipping point for PHR usage (Dameff, 2019)
- Eventual separation of data from EHR into patient-controlled, cloud-based store?

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Apple Health app

Three screenshots of the Apple Health app interface. The first screenshot shows the 'Health Records' section with categories like All Records, Allergies, Clinical Vital signs, Conditions, Immunizations, Lab Results, Medications, and Procedures. The second screenshot shows 'Lab Results' for Nov 20, 2018, including HDL Cholesterol (53 mg/dL), Non-HDL Cholesterol (129 mg/dL), LDL Chol Calc Reportable (110 mg/dL), HDL CMNT (No Hemo), and Cholesterol (LAB) (182 mg/dL). The third screenshot shows 'Conditions' for Nov 30, 2015, listing 'Nevus of choroid (disorder)', 'Presbyopia (disorder)', and 'Bilateral pseudophakia (disorder)'. It also includes entries for Oct 13, 2015, and Feb 5, 2015, and a note for Nov 21, 2013.

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Another requirement for success is competence in clinical informatics

- Clinical informatics is a core competency of health professionals education and practice (Hersh, 2014)
- Physicians and other professionals long known to be essential for success of IT in healthcare (Ash, 2003)
- Growing opportunities for training and careers in clinical informatics (Detmer, 2014)
 - Subspecialty is open to physicians of all primary specialties
 - But not those without a specialty or whose specialty certification has lapsed

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History of clinical informatics subspecialty

- 2009 – American Medical Informatics Association (AMIA) develops and publishes plans
 - Core curriculum (Gardner, 2009) and training requirements (Safran, 2009)
- 2011 – American Board of Medical Specialties (ABMS) approves; American Board of Preventive Medicine (ABPM) becomes administrative home
- 2013 – First annual certification exam offered via “grandfathering” pathway
 - 456 physicians pass
- 2014 – ACGME fellowship accreditation rules released
- 2015 – OHSU and UIC among first four fellowships launched (Longhurst, 2016)
- 2019 – now 1800+ board-certified and 35+ fellowships
- 2022 – last year for “grandfathering” pathway

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How will all this impact clinical practice?

- Physicians (Jha, 2016; Jha, 2018) and ML (Verghese, 2018) must adapt
- Will AI replace physicians (Shah, 2019) or make medicine better (Topol, 2019)?



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Questions?

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