Electronic Medical Records and AI: Starting with The Fundamentals

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Why I’m Giving This Presentation

Provide an overview of the informatics landscape in and out of the clinic, and to better appreciate where AI might fit.

Find interested explorers to collaborate with.

Overview: topics we'll cover

The Learning Health System (LHS)

Temporal and Atemporal Data (EMR)

Computable Biomedical Knowledge (CBK)

STEPS:

reconfigure the EMR based on clinical needs.

see how the LHS guides our actions as physician/patients.

see how CBK connects the EMR/LHS and how AI facilitates that.

My Experience and Journey

- Personal story: from index cards to EMRs while rotating through clinics, writing AV software, using EPIC, thinking of a better option, finding advisors, building a prototype, publishing and maintaining the software.

Restructuring and Optimizing Tools

- Restructuring and optimizing the tools we use to interact with information and knowledge is not a luxury, it is critical to work well in this era.

Before 1948, information was a subjective idea. Claude Shannon defined information not by what it says, but by **how much it reduces uncertainty.**

In the 20th century, biology was seen as a branch of chemistry. In the 21st century, it is increasingly viewed as a branch of information science.

"To understand how a cell works, we must think of it as a physical, chemical, and informational machine. ..." — Sir Paul Nurse (2020)

Electronic Records

We need to undo most of our ideas and expectations of current EMRs.

What could an EMR be if it was based on what we actually do in clinical work?

search for: martin wehlou youtube

Fundamental Architectural Needs of Clinical Software

- These are the essential requirements that define its foundational structure and behavior.

- Let’s look at two types of information that we manage in our clinics: **clinical data and business logic.**

Clinical Data and Business Logic

- **Clinical data** pertains to a particular patient, their problems and tasks. Eg. A1C, an MRI of the cervical spine, their PHQ9 scores, problem list, past surgical history, etc.

- **Business logic**: that which pertains to the work done in to manage the clinical data eg. which room a patient is in, who clicked what, the number of messages between staff members in a day etc.

What is Business Logic?

- Business logic refers to the set of rules, algorithms, and procedures that govern how data is created, displayed, stored, and modified within a software application to meet the specific needs of an organization.

KIND OF LIKE MAGIC.

https://noospherehub.web.app/games/clinic-problems.html

Core Clinical Behaviors

- Since we have patients with problems and treatments let's start with clinical data but we will bring business logic in shortly.

- Foundational behaviors: we will care for humans that have problems and we will have treatments intended to resolve the problems. This works for all the cultural types found in ethnomedicine, it can't be broken down any further and still be clinical.

Problems and Treatment in Clinics

- Problems: most often diagnoses Snomed, ICD etc.
- Problem oriented systems have been around since the 1960s <youtube: Larry Weed's 1971 Internal Medicine Grand Rounds>

- Treatments: tasks, orders, referrals, prescriptions, recommendations, procedures etc.

The Learning Health System (LHS)

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Learning Health System (LHS) Definition

- The Agency for Healthcare Research and Quality (AHRQ) defines a learning health system as a health system in which **internal data and experience are systematically integrated with external evidence, and that knowledge is put into practice.**

Aspirational Model of LHS

- A Learning Health System (LHS) is one "in which science, informatics, incentives, and culture are aligned for continuous improvement and innovation, **with best practices seamlessly embedded in the delivery process and new knowledge captured as an integral by-product of the delivery experience**" (Institute of Medicine, 2007).

The LHS Feedback Loop

- This means that data from ongoing health care encounters are continuously aggregated and analyzed, and what is learned from ongoing health care is incorporated into the improvement of future care, creating a natural feedback loop.

LHS vs. Other Improvement Processes

- Friedman states that “what makes an LHS different from other cyclic improvement processes are
- 1. at the beginning of the cycle, establishing a multistakeholder learning community that is focused on the problem and collaboratively executes the entire cycle.

Embracing Uncertainty in LHS

2. Embracing, at the outset, the uncertainty of how to improve against the problem by undertaking a rigorous discovery process before any implementation takes place.

Socio-Technical Infrastructure in LHS

3. Supporting multiple co-occurring cycles with a socio-technical infrastructure to create a learning system."

https://doi.org/10.1002/lrh2.10328

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Evolved technology allow us to connect our EHR to LHS. it needs to be temporal or realtime, like we ourselves are.

https://noospherehub.web.app/games/small-brain.html

Temporal and Atemporal Data

A unique aspect of SBR’s logic is its attempt to bridge atemporal concepts (fixed medical codes and notes) with temporal phenomena (real-time recordings).

- Continuous Data (Temporal): The system prioritizes the capture of raw, objective data from clinical encounters, primarily through audio recordings. This records the "speech-acts" of the encounter, preserving the patient's actual words and the doctor's reasoning.
- Discrete Data (Atemporal): This includes problems, orders, text notes, tasks, etc.
- The Synchronous Link: During an encounter, the clinician "tags" or accesses specific problems. This creates timestamps in the continuous audio file, effectively annotating the media with clinical context for future retrieval or machine learning analysis.

Audio as a Unique Data Type

- Let’s look at audio in a little more detail due to its uniqueness and our new analytic capacity.

Audio as Real-Time Data

- Think of audio as a type of continuous data similar to real-time arterial pressures. This can allow real-time events to be programmed such as an alarm.

- Real-time is powerful.

My Work with Audio Data

- multimedia audio is a common data type, clinically not so much. A/V software and performances > collecting data with my patients, “would you use it if i recorded it” and are you ok with this?”> Dartmouth, building open recording project

Natural Language Processing for Automated Annotation of Medication Mentions in Primary Care Visit Conversations
- Journal of the American Medical Informatics Association

Sharing Annotated Audio Recordings of Clinic Visits With Patients—Development of the Open Recording Automated Logging System (ORALS): Study Protocol
- Journal of Medical Internet Research

popular press publications:

The Appointment Ends. Now the Patient Is Listening.
- New York Times,

Medscape, Medical Economics, and others

Impact of Machine Learning (ML)

- Before machine learning (ML) it was not scalable to use audio recordings for much, that’s no longer the case. We’ve seem the same with genetic sequencing. Processing is more powerful.

Bring back business logic

- Now we can take audio recordings and predict what is going on during our encounter with regard to the clinical problems and treatments. If we allow the business logic to be automated then we can begin familiarizing ourselves with this process. See for example the Small Brain System.

EHRs and New Software Systems

- <A Next Generation EHR for Primary Care: How we learned to stop worrying and love Health IT> youtube

Role of Software in Clinical Practice

- The software should help us manage our patients and be of maximal value to the LHS so we can build and receive the best CBK to help the patient in the room with us. That is why problem, tasks, real time data are foundational.

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CBK

this is where AI and software fluidity grow.

Computable Biomedical Knowledge (CBK)

- CBK (computable biomedical knowledge) is the result of an analytic and/or deliberative process about human health, or affecting human health, that is explicit, and therefore can be represented and reasoned upon using logic, formal standards, and mathematical approaches.

Guiding principles for technical infrastructure to support computable biomedical knowledge.

https://pubmed.ncbi.nlm.nih.gov/37448456/

Evolution of Clinical Decision Support

Think of CBK as next gen clinical decision support:

past: books, journals; static print.

currently: UpToDate, guidelines from (U.S. Preventive Services Task Force, CDC, etc.);

“Clinical practice guidelines are systematically developed statements to assist practitioner and patient decisions about appropriate health care for specific clinical circumstances.” (Institute of Medicine, 1990): digital editable

Outgoing Data and Quality Metrics

- The piece of the big picture we often struggle with is outgoing data. New incentives/payment models are often built around reported data and tied to measurable quality metrics.

Embracing Discovery for Change

- Overwhelmed and burning out… OR we embrace the uncertainty of how to improve stuff by undertaking a rigorous discovery process before any implementation takes place. This is what we were taught by our mentors, take the time to do a good H&P.

Real time

- Next: real-time data loop (LHS) dynamic: a complex equation updated in real-time.

The LHS Data Flow Needs

- LHS needs
- OUT: “new knowledge captured as an integral by-product of the delivery experience”
- IN: “best practices seamlessly embedded in the delivery process”

Data as a Byproduct for LHS

- LHS: wants “new knowledge captured as an integral by-product of the delivery experience” this is a byproduct of managing the problems, actions, and measurements. This is what we do in real time during most appointments.

Benefits of Objective Data

- At the same time we want the byproduct of this work to be a training set that allows for appropriate automation.
- WE WANT OUR SOFTWARE TO BE LIKE A GOOD NURSE OR SECRETARY, THEY KNOW ME.

- So the data captured is of help to us because it automates business logic, AND to the LHS as it's highly objective and accurate. WIN WIN

Real-Time Best Practices

- LHS wants: “best practices seamlessly embedded in the delivery process” This will be in the context of managing problems and should be presented to us optimally in real time. If we don’t have continuous data to train on, we can’t do this in real time.

Summary of Needs

- In summary the fundamental needs are a system that can manage problems, tasks, and real-time data.

- That is what we want to keep in mind when we are considering changing software or policies.

Conclusion and Next Steps

- So here's what we should do:
- ensure research can happen (limited capacity for clinical research at academic institutes, etc., due to the IT dept. it's like the Dietitian at the hospital being responsible for pharmaceutical research).

Collaboration as a Key Element

- Part of our work as physicians is to ensure that the work environment we are responsible for can provide the tools we need. COLLABORATE

Embracing Uncertainty

- “…embracing, at the outset, the uncertainty of how to improve against the problem…” Friedman

Forest and trees.

- When we are selecting products or implementing digital workflows, keep in mind the LHS, CBK, Temporal and Atemporal Data.

Closing Remarks

This is too cool of an era to miss out on.

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Additional Resources

1. **Lawrence Weed's Problem-Oriented Medical Record (POMR)**:
   - **URL**:
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8076203/
   - This discusses the historical and functional significance of problem-oriented medical records in clinical practice.

2. **Learning Health Systems (LHS)**:
   - **URL**: https://nam.edu/programs/value-science-driven-health-care/learning-health-system-series/
   - The **National Academy of Medicine** provides comprehensive insights into the Learning Health System framework.

3. **Multimedia in EHRs**:
   - **URL**: https://medinform.jmir.org/
   - **JMIR Medical Informatics** has numerous papers discussing the integration of multimedia and digital tools in electronic health records.

4. **Patient and Family Engagement**:
   - **URL**: https://www.healthit.gov/faq/what-patient-engagement-and-why-important
   - The **Office of the National Coordinator for Health Information Technology (ONC)** explains the critical role of patient and family engagement in health IT.

5. **Machine Learning and AI in Healthcare**:
   - **URL**: https://www.thelancet.com/journals/landig
   - **The Lancet Digital Health** features articles on how machine learning and AI improve decision-making in clinical environments.