Artificial Intelligence & Predictive Analytics

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None
Outline
• Geisinger and Data Assets
• Motivation for AI
• AI in Patient Engagement
  • Direct
  • Indirect

Geisinger and Data Assets
Geisinger: Rich Clinical Data from Integrated Network of 13 Hospitals

1.9 Million patients
- ~500 Million labs
- >800 Million vital signs

3.2 Billion rows
- ~140,000 whole exomes sequenced → average 16 years follow-up

2 Petabytes of Radiology and Cardiology Imaging Data

"Free phenotypic data" from a Learning Health System
(Joe Leader, AVP of Informatics)
Motivation: Data Overload

One Radiologist → 50 MRI Studies/Day → 425 Images/Study → 1.52 Seconds/Image

Motivation: Data Overload and Data Waste

Findings
- Left ventricular measurements
  - End Diastolic Diameter: [ ] mm (normal, 36-56 mm)
  - Ejection Fraction: [ %] (normal: male = 56-78%, female = 56-78%)
  - End Diastolic Volume: [ mL]
  - End Systolic Volume: [ mL] (normal: male = 19-72 mL, female = 13-51 mL)
  - Indexed End Diastolic Volume: [ mL/m^2]
  - Indexed End Systolic Volume: [ mL/m^2]
  - Cardiac output: [ L/min] (normal: male = 2.82-8.62 L/min, female = 2.7-6.3 L/min)

Can we assist physicians by providing insight from all these measurements using large clinical datasets and computing?

Electronic Health Record

Global impression and clinical decision

Thousands of images → Tens of measurements
Medical Errors

• 3rd cause of death in the US
• Errors lead to
  • Decrease patient safety
  • Poor outcomes
  • Poor patient experience
  • Poor patient engagement

[http://www.bmj.com/content/353/bmj.i2139]
Additional Pressure on Patient Engagement

Pressures on Patient Engagement

Documentation Burden

Time Pressures

Shortage of Physicians

China's doctor shortage prompts rush for AI health care

Qu Jianguo, 64, had a futuristic medical visit in Shanghai as he put his wrist through an automated pulse-taking machine and received the result within two minutes on a mobile phone—without a doctor present.


AI/ML for Patient Engagement

Indirect Impact

- Timely right diagnosis and reduction of errors
- Trust building and improved engagement
- Free the providers from ‘mundane work’
  - Clinical Digital Assistant
    - AI and Voice Driven assistant for EHR and Exam Room workflow
    - Reduce time documenting notes
    - Allow clinicians to spend more time with patients
    - Allow better provider-patient interaction and engagement (the doctor will look at you now)
    - Focus on Patients not documentation
    - Reduce burn out
- Leverage Data Overload and Data Waste → Insights that were not obvious
IDx: Automatic Detection of Diabetic Retinopathy

Biomarker Detectors (mostly CNNs)

Abramoff et al, IOVS 2007
Abramoff et al, Nat Dig Med 2018

Image Quality Assessment

Clinical Decision

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Helping Providers

Can we do the same for Radiology?

Is there an opportunity to remove “Normal” and “Incidental” exams from the queue so Radiologists can focus on reading complex “Abnormal” exams?

Perhaps engage patients directly to explain the results?
Helping Providers
Lung Cancer Screening (Arterys)

High clinical acuity patients + High priority → Studies read Fast

Low clinical acuity patients + Lower priority → May take Longer Time

• Higher acuity patients hiding in the low clinical acuity setting

How do we help these patients?
Helping Providers – Deeper Dive


Results

• Good Performance: AUC = 0.85
• Chose balanced operating point (yellow circle)
Worklist Reprioritization

GOAL: read the most acute studies 1st

Radiology worklist
- Case 1
- Case 2
- Case 3
- ... 
- Case 40
- Case 41
- Case 42

Neural Network

Types of Hemorrhages Detected

True Positive Cases

A B C D E F G H I J
Clinical implementation of a machine learning algorithm reduced time to diagnosis of new outpatient cases of intracranial hemorrhage by 96%. Approximately 10% of “false positives” - subtle hemorrhage?

Direct Impact - Nonclinical

Predicting Denials

Predict no-shows and cancellations

Determine the appropriate appointment length

Direct Impact - Clinical

• Engaging Patients to Address Care Gaps
  • AAA
    • Machine NLP ‘reads’ Radiology Reports → Find patients who are at risk and have a care gap → Work with Primary care providers to engage the patient and start appropriate treatment pathway
  • Colon cancer screening
    • Can we use existing data (CBC, age, gender, etc.) to risk stratify patients?
    • Yes
  • Finer Points of Lung Cancer Screening
    • NLCS (National Lung Cancer Screening) trial – broad strokes recommendations
    • Can we have more granular recommendations?

Direct Impact – Risk Stratification

Data-Driven Risk Model

Level 1 → Care team X
Level 2 → Care team Y
Level 3 → Care team Z

Increasing Risk

Old

New

Billing Data

Current State

Machine Learning

Lab
Vitals
Imaging

Brandon Fornwalt and Alvaro Uloa
Helping Providers Engage Patients

ECG for survival and atrial fibrillation prediction
- Is there a ‘signal’ in ‘normal’ ECG’s to predict future events?
  - Brandon Fornwalt, Sushravya Raghunath
  - Recent Paper in Lancet by Attia et al.

EMR data for stroke prediction
- Can laboratory and EMR data predict risk of a stroke?
- Allows identification of the most important modifiable factors driving the risk, allowing intervention to reduce the risk
- Limited Trial starting in November
  - Clemens Schirmer, Dhruv Mathrawala

Summary
- AI and ML have a definite role in improving Patient Engagement by either
  - Indirect impact
  - Direct impact