Health Industry Forum 2017

Artificial Intelligence in Medicine

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Agenda

- Background on AI: a primer
- Separating Hype from Reality
- Examples & Use-cases
- Roadmap & Next Steps
- Q & A

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Background on AI: De-mystification

- Artificial Intelligence (AI): Activity that resembles human capabilities of association, learning, and insight
- Machine Learning (ML): Math and Software that replicate & extend human capabilities of pattern recognition & learning
- ML applies statistics & modeling in software to:
  - Represent essential features of the world
  - Allow software to update its performance in response to training
  - Allow software to identify new patterns of association in data
- **Uses:**
  - Classification: assigning something to a meaningful category
  - Data Mining: finding patterns of association in data (clustering)
  - Dimensionality Reduction: mapping many to few, assigning topics

Background on AI: De-mystification

- Supervised Learning: ML that employs training examples (reference data) provided by people.
  - Example: handwriting interpretation (US Postal service)—classify inputs based on meaningful categories (alphabet letters) & training cases
- Unsupervised Learning: ML that groups data based on mathematical & statistical properties of the data
  - Example: data mining. Finding potentially new associations in data. Software scans large data, but can't assign meaningful categories (classification)

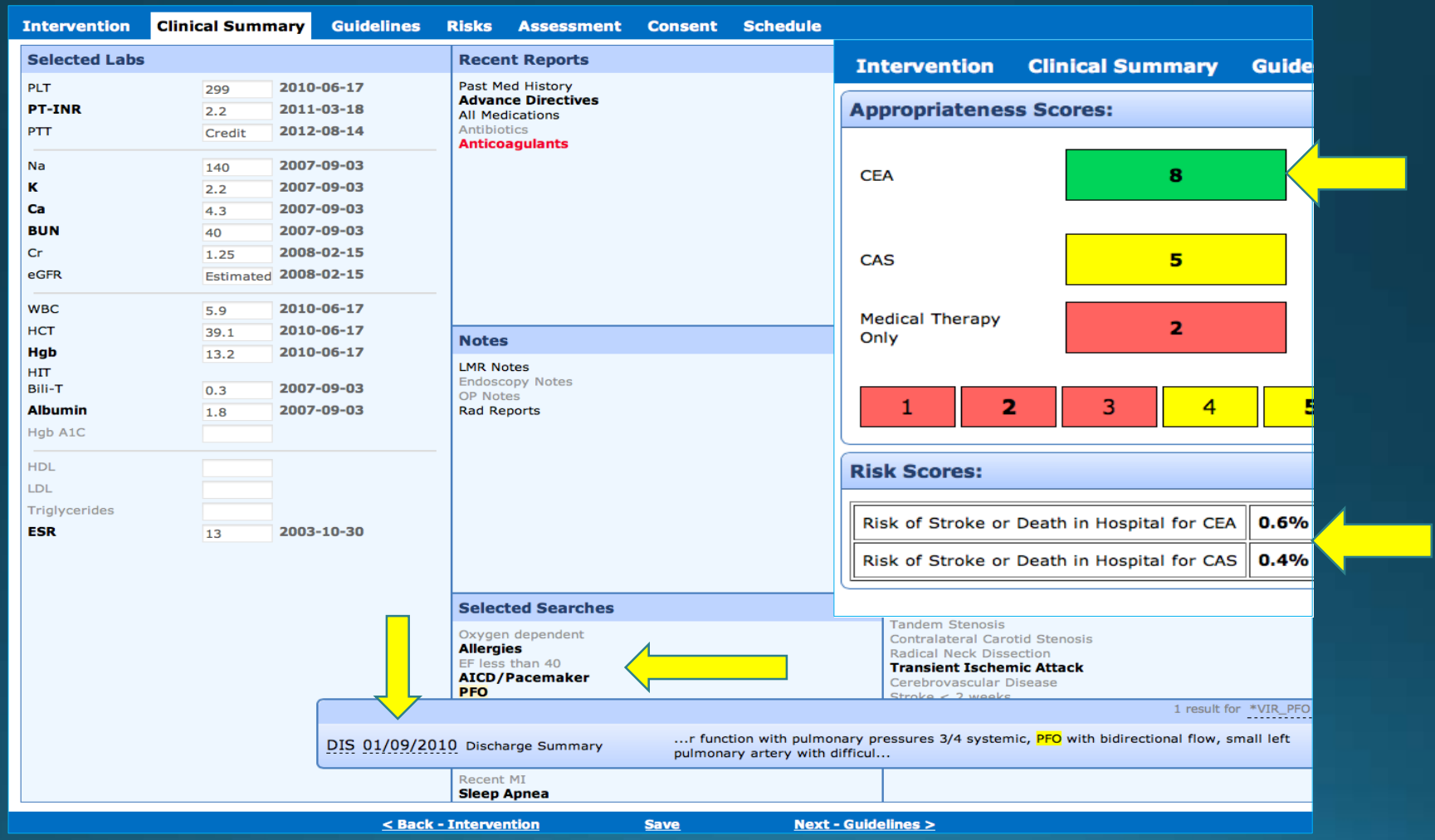
Separating Hype from Reality

- There's no escaping statistics
  - Performance inversely relates to complexity, capture & volume of data
  - Engineering features (abstraction) is expensive
  - Training Data is expensive
- Healthcare is a human endeavor
  - Policy, Policing, & Payment are based on human exercise of independent clinical judgement and action
  - Technology moves much faster than regulation & the law
  - Humans don't trust 'black boxes': be skeptical of magic & panaceas
- A worthy goal: AI supports humane care
  - Reduce hassle of necessary administrative oversight
  - Elucidate what treatments are most effective & efficient
  - Help people contend with a rising tide of data
  - Prioritize & support meaningful human interactions

Illustrative Use Cases: Improved Utilization Management

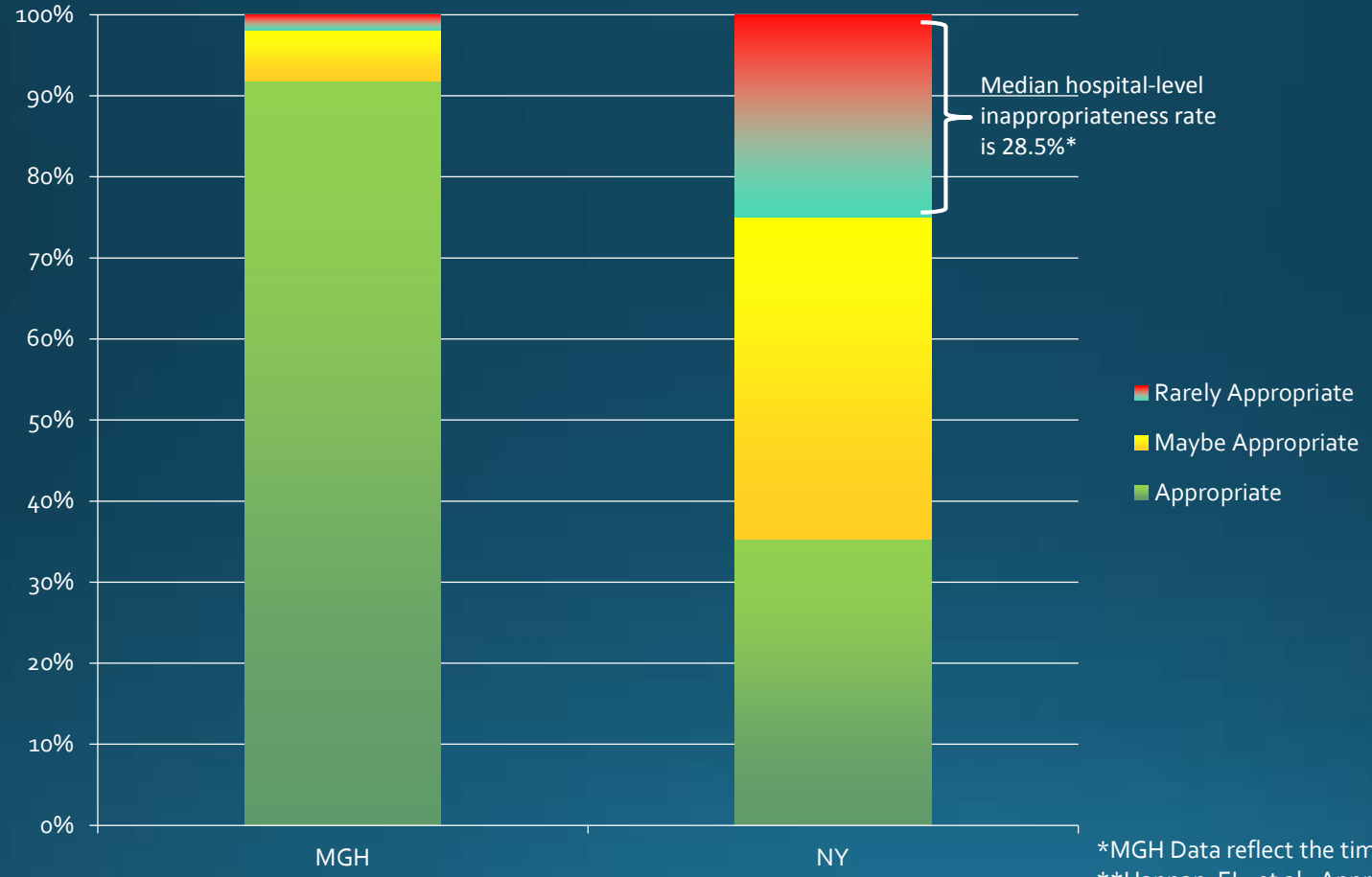
- **Problems:**
  - Evidence Based Guidelines are very complicated (branching trees)
  - Reconciling a patient's record (EHR) with guidelines is laborious
  - Yet: appropriateness improves with evidence-based practice
  - Distillation: how do we make guidelines ergonomic & useful in practice?
- **Approach:**
  - Leverage Natural Language Processing (NLP) to expedite information retrieval from EHR, *organized by clinical logic*
  - Employ Data Science to prune guidelines complexity as appropriate
  - Operationalize all of this in browser-based, HIPAA-compliant software
- **Implementation:** At Massachusetts General Hospital (MGH) and Partners Healthcare as part of order work-flow (PrOE)
  - Key collaborators: Tim Ferris MD, Creigh Milford MD, Mitch Harris PhD, Sid Govindan MD, Jim Zawisa Msc

Illustrative Use Cases: Improved Utilization Management



Illustrative Use Cases: Improved Utilization Management

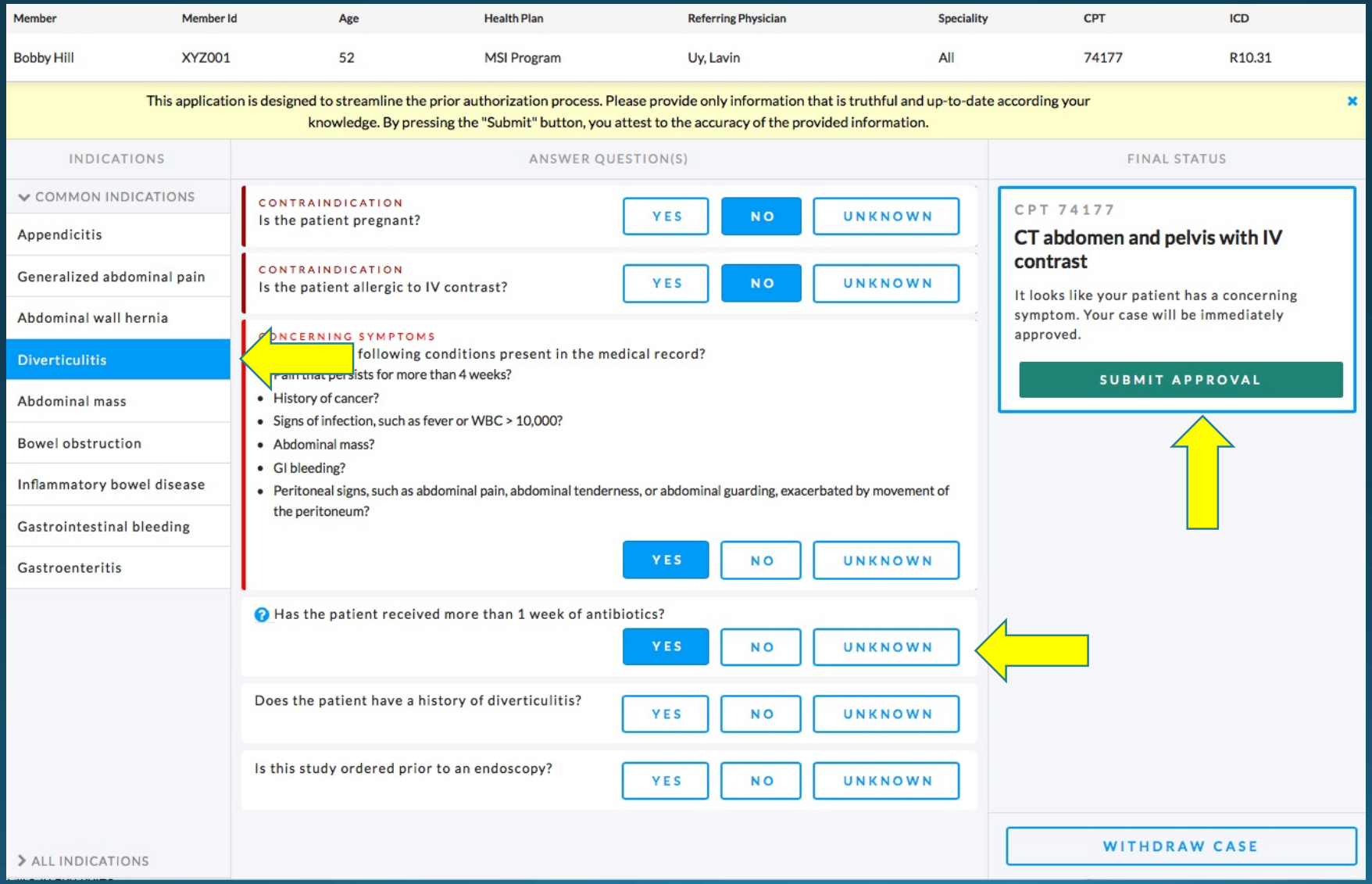
Appropriateness Scores for Diagnostic Catheterization for Suspected CAD at MGH* vs. NY Cardiac Database**



*MGH Data reflect the time period 8/2013- 8/2014.

**Hannan, EL, et al. Appropriateness of Diagnostic Catheterization for Suspected Coronary Artery Disease in New York State. CIRC INTERVENTIONS. January 28, 2014. 113.000741

Illustrative Use Cases: Improved Utilization Management



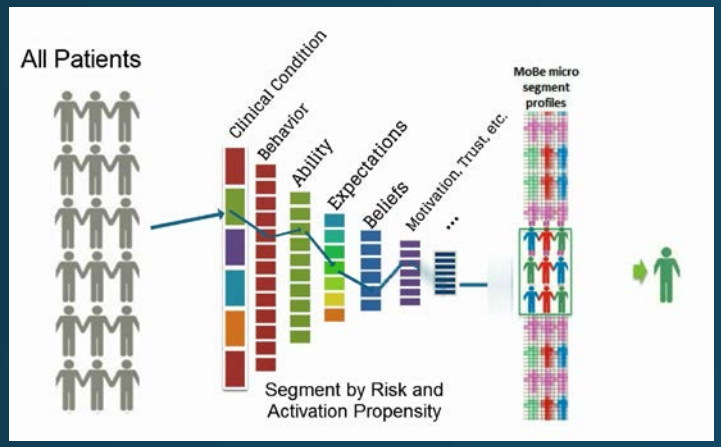
Improved Utilization Management: Implementation and scaling issues

- **Lessons Learned:**
  - **Innovation *can* satisfy multiple stakeholders (patient, clinician, payer)**
  - **EHR interoperability (free flow of data, open workflow) remains poor**
  - **Market dynamics complex for utilization management**
- **Problems:**
  - NLP ability to answer questions using unstructured EHR data is limited
  - Challenge to acquire enough training data for models & NLP
  - Business case challenge: who really benefits from improved workflow?
    - Key stakeholders do not necessarily value workflow & experience innovation
  - Workflow challenge: integrating fully functional software in EHR

Outpatient Examples:

- Machine Learning for IoT
  - Patient facing self-management applications (Diabetes, Depression)
  - Home monitoring devices (Home activity monitoring)
- Patient Micro-segmentation for Population Health
  - Mass customization of outreach efforts
  - Constant optimization of best ways to promote change
- Provider Documentation Workflow Optimization
  - Ability to adapt to how a provider uses the EMR
  - Voice analytics augment dictation to ambient "scribe" functions
- Key Activities
  - Monitoring daily volume of streaming monitoring data from devices
  - Detect baseline and changes from baseline (Filter signal from noise)
  - Customize alerts appropriately for patient/provider/situation

Outpatient Examples:



- Population Health:
  - Behavior patterns
  - Continuous looped learning
  - Individualized plan
  - Customized action
- ML active population surveillance fits cyclic nature of chronic condition management.
- Can optimizes provider and patient time and efforts and reduce empirical trial/error.

Roadmap & What's ahead

- **Matching modeling (ML) to problems**
  - Appropriateness determination
  - Feature recognition (radiology)
  - Clinical trial recruitment
  - Genomic mapping, disease & drug response prediction
- **Improve & clarify the interaction between AI & people**
  - Regulation & software ethics: defining who is taking responsibility
  - Technical evolution: AI that can explain it's rationale to a human
- **Bringing models to the data (and staying HIPAA compliant)**

Conclusions:

- AI has the potential to help us re-think healthcare delivery
- Despite technical challenges, there are real use cases today
- Policies and regulations need to mature around use of patient data (AI training) and advanced decision support (AI augmented automation) to safely accelerate development
- Resist hype: AI is not magic, and it's not a panacea
- AI can extend, but not replace human insight & judgement