NATIONAL ACADEMY OF MEDICINE

DIGITAL LEARNING COLLABORATIVE (DLC) MEETING

NOVEMBER 30, 2017 Meeting Highlights

MEETING FOCUS: Artificial Intelligence, machine learning, and the future of continuous health learning and improvement

Meeting Objectives:

1. *Aim:* Consider the nature, elements, applications, state of play, and implications of Artificial Intelligence (AI) and Machine Learning (ML) in health and health care, and ways in the National Academy of Medicine might enhance collaborative progress.
2. *AI/ML opportunities:* Identify areas within health care for which AL and ML have already shown promise. Consider implications for other applications.
3. *Barriers:* Identify and discuss the practical challenges to the advancement and application of AI and ML, including those related to data integration, ethical/regulatory implications, clinician acceptance, workforce development, and business case considerations.

Expected outcome: Establishment of a charge and charter for an ongoing NAM Collaborative Working Group for information sharing and facilitating the application of AI and ML for better health.

REPRESENTATIVE OBSERVATIONS

- The discussion began with an introduction of ML for health care with a description of key terms including supervised learning, transfer learning, unsupervised learning with clustering or binning, and anomaly detection. The most important requirements for ML to work are having the right training data and involving clinicians. (CB)
- The National Center for Advancing Translational Sciences' (NCATS) Biomedical Data Translator program aims to integrate clinical, biological, and other research data to permit a molecularly-driven, virtuous cycle of continuous care improvement. (NS)
- For ML to be truly useful, it is necessary to integrate data sources to generate a signal, to integrate ML outputs back into the clinical workflow in a way that is explainable to clinicians, and then to use data to track outcomes, continuously harvesting the data exhaust. (JP&EJ; JF) Each patient can generate 350 different data streams and there can be hundreds of clinicians who need to be able to view the output of AI/ML algorithms. (JF)
    - Hospital Corporation of America (HCA) successfully developed a ML algorithm for early sepsis detection - SPOT (Sepsis Prevention and Optimization of Therapy) - and integrated it into clinical care, resulting in 5,500 patients saved over the last 3 years. (JP&EJ)
- Deep learning is a type of machine learning that can integrate multiple variables in deep neural networks to classify data. In health care, deep learning is showing promise in a number of areas including improving image recognition and administrative processes. (PB)
- The VA is undertaking a number of projects designed to leverage data to develop ML algorithms to improve care, including developing prediction approaches that match high-need patients to appropriate care models. This experience demonstrated that quality and quantity of data are more important than modeling techniques, and quality control and avoiding clinician overload are also critical. (SF)
- A challenge for ML in health care is the huge amount of unlabeled data (DF; TE). Vanderbilt and Maize Analytics developed a ML algorithm using unsupervised learning techniques with unlabeled data to improve review of inappropriate access to patient data in the EHR. The algorithm filters out data on access that makes appropriate logical sense based on the event structure so privacy staff can focus on review of suspicious cases. (DF)
- Another bottleneck to effective ML is machine education, which is the process of rapidly re-building models as an increasing number of examples become available. Digital Reasoning was able to effectively build and re-educate a ML model that can efficiently identify cancer patients by looking at pathology reports. Using the output, patient can be routed to care more efficiently, decreasing the time for detection from 2 weeks to 2 days. (TE)
- There are a number of legislative, regulatory, and other mechanisms that could be used to oversee the accuracy, quality, and safety of ML products, including, for pre-market review, peer review, the FDA CDRH 510(k) process, CLIA processes, and, for post-market review, litigation through the court system (civil, criminal, or discriminatory), or certification by standards organizations or specialty boards. (DM)
- The FDA Digital Health Innovation Action Plan describes the agency's efforts to ensure access to digital health products that are safe and effective through regulating the manufacturer rather than the product. (SK)
- For ML algorithms to be impactful, predictions must be explainable, and users should know what the intervention should be based on the predictions, who is responsible for providing the intervention, and the potential effect on the doctor-patient relationship. (NS) Also critical are workflow issues and the user experience. There are multiple potential uses of ML in health care and the ethics and workflow issues will be different for each. (SH)
- Related to explainability, there are several active areas of research: methods for visualizing model outputs in clinically interpretable ways, using simpler models on top of ML to improve interpretation, and explaining individual prediction versus the overall model. (MM)

ISSUES FOR COLLABORATIVE CONSIDERATION

Issues mentioned that could be addressed through a NAM AI/ML Collaborative Working Group to accelerate progress include:

- *Facilitating workflow integration*: Understand the technical, cognitive, social, and political factors in play (WC) and incentives impacting integration. (LD)
- *Enhancing explainability & interpretability*: To promote integration, consider what needs to be explained and approaches for ensuring understanding.
- *Workforce education:* Promote educational programs to inform clinicians about AI/ML approaches and to develop an adequate workforce.
- *Oversight and regulation:* Consider the appropriate regulatory mechanism for AI/ML and approaches for evaluating algorithms and their impact.
- *Problem identification and prioritization:* Catalogue the different areas of health care and public health where AI/ML could make a difference, focusing on intervention-driven AI, but avoid picking winners.
- *Clinician & patient engagement:* Understand the appropriate approaches for involving consumers and clinicians in AI/ML prioritization, development, and integration, and the potential impact of AI/ML algorithms on the doctor-patient relationship.
- *Data quality & access:* Developing effective AI/ML algorithms requires large amount of high-quality data. Promoting data quality, access, and sharing, as well as the use of both structured and unstructured data and the integration of nonclinical data is critical.

THE LEARNING HEALTH SYSTEM SERIES

Participants

Jonathan Perlin (Hospital Corporation of America), Reed Tuckson (Tuckson Health Connections), Doug Badzik (Department of Defense), Carlos Blanco (National Institute on Drug Abuse), Paul Bleicher (OptumLabs), Carla Brodley (Northeastern University), John Burch, Wendy Chapman (University of Utah), Jonathan Chen (Stanford University), Leonard D'Avolio (Cyft), Shahram Ebadollahi (IBM Watson Health Group), Tim Estes (Digital Reasoning), Daniel Fabbri (Vanderbilt University Medical Center), James Fackler (John Hopkins Medicine), Steve Fihn (University of Washington), Kenneth R. Gersing (NIH), Seth Hain (Epic Systems), Michael Howell (Google), Brigham Hyde (Precision Health Intelligence), Edmund Jackson (Hospital Corporation of America), Javier Jimenez (Sanofi), Sean Khozin (FDA), Hongfang Liu (Mayo Clinic), Jennifer MacDonald (VA), Michael E. Matheny (Vanderbilt University), Douglas McNair (Cerner), Wendy Nilsen (NSF), Matthew Quinn (HRSA), Joachim Roski (Booz Allen Hamilton), Robert E. Samuel (Aetna), Nigam H. Shah (Stanford), David Sontag (MIT), Noel Southall (NIH), Bob Tavares (Emmi Solutions), Sonoo Thadaney (Stanford Medicine), Howard Underwood (Anthem), Shawn Wang (Anthem), Daniel Yang (Moore Foundation), Maryan Zirkle (PCORI)

DIGITAL LEARNING COLLABORATIVE

Participating Organizations

AAMC
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ABMS
ACMG
AstraZeneca
AHIP
AHA
AMA
Baylor Scott & White
Blue Cross and Blue Shield
Brigham and Women's
Bristol-Myers Squibb
Brookings Institution
Cedars-Sinai Medical Center
CMTP
Christiana Care
Duke University
Epic Systems
Fairfaix Family Practice
Georgetown University
Harvard University
ICER
Institute Hlthcre Imprvmnt
Intermountain Healthcare
Temple University
John Hopkins University
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Outcome Sciences Inc.
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– Office of the Secretary
– AHRQ
– CDC
– CMS
– FDA
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– ONC
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