

**NATIONAL LIBRARY OF MEDICINE, NIH**  
**BOARD OF SCIENTIFIC COUNSELORS**  
**MEETING MINUTES**  
**April 23, 2020**

The Board of Scientific Counselors of the National Library of Medicine (NLM) convened by webcast on April 23, 2020, between 11:00 a.m. and 5 p.m. The meeting was open for viewing by NLM staff via NIH VideoCast.

**BSC Members Participating**

Michael Boehnke, PhD, University of Michigan  
Stephen Downs, MD, Indiana University School of Medicine  
Kevin Johnson, MD, Vanderbilt University Medical Center (*BSC Chair*)  
Kateryna Makova, PhD, Penn State University  
Susan Matney, PhD, Intermountain Healthcare  
Shawn Murphy, MD, PhD, Harvard Medical School  
Ming Jack Po, MD, PhD, Google Health  
Katherine Pollard, PhD, University of California  
Steven Salzberg, PhD, Johns Hopkins University  
Donna Slonim, PhD, Tufts University  
Pamela Soltis, PhD, University of Florida  
Jessica Tenenbaum, PhD, Duke University

**BSC Ad hoc Members Participating**

Anna Rumshisky, PhD, University of Massachusetts Lowell  
Cathy Wu, PhD, University of Delaware

**NIH Staff Participating**

Sameer Antani, PhD, LHC, NLM  
Olivier Bodenreider, MD, PhD, LHC, NLM  
Patricia Flatley Brennan, RN, PhD, NLM  
Milton Corn, MD, NLM (*BSC executive secretary*)  
Jonas De Almeida, PhD, NCI  
Charles Dearolf, PhD, OD, NIH  
David Landsman, PhD, NCBI, NLM  
James Mork, LHC, NLM  
Jerry Sheehan, NLM  
Steve Sherry, PhD, NCBI, NLM  
(additional staff watched by videocast)

**NLM Investigators Receiving Reviews**

Dina Demner Fushman, PhD, LHC, NLM  
Travis Goodwin, PhD, LHC, NLM  
Zhiyong Lu, PhD, NCBI, NLM

## **NLM Fellows Participating in Poster Session**

Qingy Chen, PhD, NCBI

Asher Moldwin, PhD, LHC

Yifan Peng, PhD, NCBI

Protiva Rahman, PhD, NCBI

Max Savery, PhD, LHC

### **1. Welcome, Introductions, Scheduling – Kevin Johnson**

Dr. Johnson welcomed participants to the meeting and briefly outlined the meeting agenda. The two Ad hoc reviewers – Anna Rumshisky and Cathy Wu – introduced themselves.

### **2. Remarks from NLM Director – Patricia Flatley Brennan**

Dr. Brennan thanked the BSC members for their service and the NLM intramural investigators for their work. She briefly covered several areas in her presentation:

#### Personnel Actions

- Dr. Milton Corn is now the Acting Scientific Director for NLM, working with both Lister Hill Center (LHC) and the National Center for Biotechnology (NCBI). Dr. David Landsman continues to serve as Deputy Scientific Director for NCBI.
- Dr. Stephen Sherry is now the Acting Director of the National Center for Biotechnology, following the retirement of Dr. James Ostell, who may return to NLM as a special volunteer.
- Dr. Lauren Porter has joined the NLM's Intramural Research Program. Dr. Porter is a Stadtman fellow and has a joint appointment with the National Heart Lung and Blood Institute.
- Dianne Babski is now the Acting NLM Associate Director for Library Operations, following the retirement of Joyce Backus.
- Kim Pruitt has been formally named Chief of NCBI's Information Engineering Branch; she previously was serving as Acting Chief.

#### NLM Resources Responding to COVID-19

- PubMed Central (PMC) has expanded access to approximately 40,000 machine-readable articles related to COVID-19. PMC is participating with the Allen Institute for the COVID-19 Open Research Dataset (CORD-19) initiative, which is making machine-readable coronavirus literature available for textmining.
- ClinicalTrials.gov currently provides records on more than 350 clinical studies related to COVID-19, ranging from prophylaxis to therapeutics. ClinicalTrials.gov also is partnering with WHO to include COVID-19 studies from their database.
- GenBank has developed a fully automated system whereby SARS-CoV-2 sequence submissions are processed and released within 24 hours.
- Using AI, NLM researchers developed LitCovid, a hub for COVID-19-related literature that lets users drill down into different areas, such as research categories and geographic regions.

- NLM is updating its standards and terminologies for COVID-19, including resources such as UMLS, MeSH, RxNorm, LOINC, Common Data Elements Repository, and Value Set Authority Center (VSAC).
- NLM is supporting its national network of libraries of medicine in their work responding to COVID-19 and filling in for closed public libraries and hospital libraries.

#### COVID-19 Funding

- NLM received an extra \$10M for COVID-19 work through the third stimulus package. The funds are being spent in three areas.
- A portion of the funding is going for improving quality of clinical data for research and care. This category includes implementing guidelines, training, and addition of codes to support COVID-19-related lab tests within LOINC. Also included is VSAC Fast Healthcare Interoperability Resources (FHIR) API development to enable standardized sharing of COVID-19 terminology updates.
- Another portion of funding is slated for accelerating research. This includes extramural work on mining clinical data for deep phenotyping models that can be used to identify or predict the presence of COVID-19. LHC also is using machine learning/AI on images and clinical data to support clinical decisions in real time. NCBI and extramural researchers are working on public health surveillance using virus genomics, health data and social media data to identify the spread of COVID-19.
- Lastly, funding is going towards enhancing access to COVID-19 literature and molecular data resources. Projects in this category include supporting chemical editing for COVID-19-related drugs and chemicals; ensuring NLM COVID-19 collection materials are available electronically; ensuring access to literature when public health events close libraries; extending PMC submission workstreams to facilitate AI/machine learning; developing a PubMed portal for COVID-19 literature collected through LitCovid text mining; ensuring rapid sequence submission and access through GenBank and VirusHub; and using SRA in the cloud for viral surveillance and discovery.

#### Other

Dr. Brennan also described plans to modernize ClinicalTrial.gov and plans to renovate NLM's building/office facilities. In addition, she noted the increase in NLM's budget (from \$442M to \$456M) and detailed NLM's Data Science Training Program, which is in its second year.

### **3. Presentation and Review of Zhiyong Lu, Senior Investigator**

Dr. Lu's group conducts research primarily in natural language processing (NLP), machine learning/deep learning, and medical image analysis. He focused his presentation on three areas of his group's work: PubMed search, information extraction and concept recognition, and deep learning.

#### PubMed Search

Dr. Lu explained that his group used artificial intelligence (AI) and machine learning (ML) to develop a "Best Match" algorithm that optimizes the relevance of search results, particularly in the first page of results. The key ranking factors include relatedness of the document to the query, article type, publication date, and past usage of the article. Analysis of PubMed search

logs shows that the click-through rate with the Best Match sort is 20% higher than when results are ordered through the traditional date-based system. PubMed users can choose to use either the date-based sort (most recent articles first) or Best Match. Since June 2017, there has been a 60% increase in the use of Best Match, and user feedback has been very positive, Dr. Lu noted.

Future PubMed research projects include adding search of the full text of articles. Approximately 6 million full-text articles are available in PMC, or about 20% of the 30 million abstracts/citations in PubMed. Simply merging the full text with the abstracts does not improve retrieval quality. Instead the research will look at ways to improve search by weighting the importance of terms based on their location in an article. Dr. Lu expects to first look at queries where users receive zero results, a category that makes up 10%-15% of total searches.

Another planned direction is improving author name disambiguation (distinguishing between authors with the same name). Lu's team will be looking at ways to leverage use of ORCID's (unique IDs for researchers), which are receiving increased use in PubMed, with approximately 30% of articles published in 2019 linked to at least one ORCID.

#### Information Extraction and Concept Recognition

Dr. Lu described the general issues involved in information extraction/concept recognition research, and then highlighted one particular system his group developed – PubTator – as representative of his work in this area. PubTator, available both as a web-based tool and an API, accelerates manual curation of literature (for example, annotating biological entities) through the use of advanced text-mining techniques. In 2019, Lu's group released a second version of PubTator that expanded content from abstracts in PubMed to the full text of articles in PMC. Work on PubTator is continuing, with research into further improvement in tagging performance as well as building benchmarking datasets of full text articles.

#### Deep Learning in Medical Imaging & AI with COVID-19 Literature

Dr. Lu described his group's work with National Eye Institute researchers on use of deep learning to classify retinal images for use in diagnosis and prognosis of Age-related Macular Degeneration (AMD). Among the projects, the group studied deep learning for classification of AMD severity, for automated detection of geographic atrophy (the defining lesion of the atrophic form of late AMD), and for prediction of the risk to progress to late AMD. The studies found that the deep learning methods matched or exceeded the performance of retinal specialists. The group also studied, and had positive results with, deep learning for automated detection of reticular pseudodrusen, a disease feature that is associated with increased risk of progression to late AMD.

Dr. Lu also described LitCovid, a site his group developed that serves as a curated literature hub for tracking the latest published information about the 2019 novel coronavirus.

#### Q&A, Closed Session

There was a brief Q&A after Dr. Lu's presentation, after which the BSC went into closed session with Dr. Lu.

#### **4. Presentation and Review of Dina Demner-Fushman, Tenure Track Investigator**

Dr. Demner-Fushman's research focuses using artificial intelligence approaches to enable access to reliable health-related information while advancing foundational NLP tasks. In her presentation she highlighted her group's work in three areas: consumer health question answering, answering visual questions, and #COVIDSearch, an initiative out of the White House Office of Science and Technology Policy and the Department of Commerce's National Institute of Standards and Technology.

### Consumer Health Question Answering

Dr. Demner-Fushman explained the types of consumer inquiries that are typically sent to MedlinePlus and NLM's customer services group. Frequent question types include those about a known disease, procedures and medications, diagnosis for given symptoms, lifestyle issues, and finding experts or support groups. She presented data on the questions for which answers are available through Medline Plus and other resources. She also described the difficulties in interpreting consumer questions because of misspellings, abbreviations, ambiguity of questions, and other reasons, as well as the difficulties in providing consumer-friendly answers. She then outlined her group's CHiQA question-answering approach.

Recent work with the CHiQA approach included exploring question understanding and simplification, selection of answers using traditional information retrieval approaches, alternative approaches to question answering, such as answer retrieval based on question entailment, and question-driven text summarization for answer generation.

Going forward, Dr. Demner-Fushman noted a number of areas she would be exploring, including:

- approaches to single and multi-document question-driven summarization
- approaches to validate recency and completeness of consumer-oriented answers using the latest scientific publications
- approaches to translation of original literature or professional summaries into lay language
- how and when to ask follow-up questions
- how to infer answers given several documents
- whether answers need illustrations and approaches to finding appropriate illustrations for generated answers

### Answering Visual Questions

Dr. Demner-Fushman briefly described her group's research in answering visual questions, which was based on her ongoing work in merging text and visual features. The research, which primarily used an open-access subset of PMC, involves providing textual answers to the questions asked about images. Research is continuing this year in two areas: answering image abnormality questions – which have shown a lower accuracy than questions relating to modality, plane or organ – and research approaches to question generation. Dr. Demner-Fushman noted that an intermediate step could be generating image captions and then based on the captions, generating questions and answers. In addition, she expects to begin exploring video questions answering.

### #COVIDSearch

Dr. Demner-Fushman described the history of the Text REtrieval Conference (TREC) and Text Analysis Conference (TAC) and detailed the current TREC-COVID project, which aims to evaluate systems for helping to manage the corpus of scientific literature related to COVID-19 and to discover methods that will assist with managing scientific information in future global biomedical crises. The first TREC-COVID task is ad hoc retrieval; 56 research groups are participating. Dr. Demner-Fushman noted that there were 30 initial topics, increasing by five topics every round for five-plus rounds.

#### Q&A, Closed Session

There was a brief Q&A after Dr. Demner-Fushman's presentation, after which the BSC went into closed session with Dr. Demner-Fushman.

### **5. Presentation and Review of Travis Goodwin, Independent Research Scholar**

Dr. Goodwin began his presentation by noting that he is a second-year post doctorate research fellow at NLM who is participating in NIH's Independent Research Scholar Program. Under the program, his appointment is for three years and his progress is reviewed every 18 months either by convening a review committee or using the BSC for the review. Candidates are encouraged to apply for K99/R00 grants and/or NIH Investigator positions, with the intent that the majority will be retained in the Intramural Research Program. Dr. Goodwin's mentor is Dr. Demner-Fushman and his co-mentor is Dr. Clem McDonald.

Dr. Goodwin's main research objective is to develop automatic, artificial intelligence models of disease and health processes. This entails several components: leveraging disparate data sources, such as unstructured clinical notes and laboratory results; harnessing the implicit relationships in EHRs; overcoming the incomplete and underspecified nature of clinical notes; capturing patterns in latent patient subpopulations; and inferring causal and temporal interactions between observations recorded at different times during a patient's stay.

He explained that the research motivations are that unstructured data can provide important nuanced and contextual information not available in a tabular format, such as: degrees of belief (e.g., a physician might indicate possible diagnoses or conditional treatments); relationships (e.g., a physician might indicate what aspect of the clinical picture is being addressed by a particular clinical intervention); and interpretations (e.g., a physician might indicate that a typically abnormal lab value is normal in the patient's history). Dr. Goodwin said that to his knowledge his research is the first approach to process sequences of clinical notes in order to predict nosocomial disease risk.

Dr. Goodwin described three projects he is working on:

#### Early Risk Prediction from Critical Care Notes

This project included studies to predict nosocomial disease from clinical notes, including a first study in pneumonia, followed by studies in acute kidney injury, pressure injury, and anemia. The main goal of the latter three studies was to create a customizable model for disease and health processes that could predict disease risk and outcomes. Future work in this area includes combining structured and textual information and using reinforcement learning frameworks.

#### Clinical Language Understanding Evaluation (CLUE)

One of the issues learned from the disease modeling project described above is that there isn't much research in processing sequences of healthcare documents. Dr. Goodwin noted that extracting and processing clinical text requires a lot of engineering to account for the many idiosyncrasies of EHRs. The goal of this project was to reduce the barrier of entry and foster more research in this area by preparing and releasing benchmark collections for six clinical understanding tasks to support generalizable longitudinal modeling of disease and outcomes. The six tasks were prediction from clinical notes of: worsening acute kidney injury, worsening pressure injury, worsening anemia, 25 phenotypes, all-cause mortality, and remaining length of stay. Future work in this area includes incorporating structured information to see how it complements unstructured information, and using the CLUE benchmark as a form of multi-task pre-training for disease modeling.

#### Consumer Health Answer Summarization

Dr. Goodwin described this as a more minor project that is adapting lessons learned from the CLUE project to support the answer summarization project that Dr. Demner-Fushman described. The project is looking at how to summarize answers to consumer health questions without labeling and generating answers to thousands of questions by instead first pre-training on a large body of related tasks, such as single-document summarization, multi-document summarization, logical argumentation, discourse analysis, question answering, and language simplification. Dr. Goodwin noted that this work is ongoing but has produced promising results so far.

#### Future Work

Dr. Goodwin also described future work that was planned and proposed after he prepared his report to the BSC. One project is a question answering track on COVID-19. The goal of the project is to foster research and evaluate systems on the ability to provide timely and accurate expert-level answers for the scientific/medical communities and consumer-friendly answers for the public.

#### Q&A, Closed Session

There was a brief Q&A after Dr. Goodwin's presentation, after which the BSC went into closed session with Dr. Goodwin.

### **6. Poster Session**

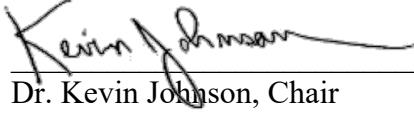
Five NLM researchers who work with Dr. Lu or with Dr. Demner Fushman and/or Dr Goodwin presented their posters:

- LitCovid: Keeping Up with the Literature on COVID-19 – Qingyu Chen, Alexis Allot, and Zhiyong Lu
- Clinical Natural Language Processing and Deep Learning in Medical Image Analysis – Yifan Peng, Xiaosong Wang, Ke Yan, Yuxing Tang, Youbao Tang, Veit Sandfort, Ronald M. Summers, Zhiyong Lu
- Evaluation of MeSH Indexing for PubMed Retrieval – Protiva Rahman, Lana Yeganova, Rezarta Islamaj, Won Kim, Don Comeau, Zhiyong Lu
- Using Deep Learning to Summarize Answers to Health Questions – Max Savery, Asma Ben Abacha, Soumya Gayen, Dina Demner-Fushman

- Analyzing Medical Concept Mentions in Longitudinal Clinical Notes – Asher Moldwin, Travis R. Goodwin, and Dina Demner-Fushman

**7. Report to Acting Scientific Director – Kevin Johnson**

The BSC met in closed session to report to the Acting Scientific Director, Milton Corn.

 6/12/20  
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Dr. Kevin Johnson, Chair (Date)  
Board of Scientific Counselors

 6/15/2020  
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Dr. Milton Corn (Date)  
Acting Scientific Director, NLM