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Perspective

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How the National Library of Medicine should evolve in an era of artificial intelligence

Leslie Andrew Lenert, MD, MS[1,*]

[1]Biomedical Informatics Center, Medical University of South Carolina, Charleston, SC 29405, United States
*Corresponding author: Biomedical Informatics Center, 22 West Edge Suite 213, Charleston, SC 29405, United States (Lenert@musc.edu)

Abstract

Objectives: This article describes the challenges faced by the National Library of Medicine with the rise of artificial intelligence (AI) and access to human knowledge through large language models (LLMs).

Background and Significance: The rise of AI as a tool for the acceleration and falsification of science is impacting every aspect of the transformation of *data* to *information*, *knowledge*, and *wisdom* through the scientific processes.

Approach: This perspective discusses the philosophical foundations, threats, and opportunities of the AI revolution with a proposal for restructuring the mission of the National Library of Medicine (NLM), part of the National Institutes of Health, with a central role as the guardian of the integrity of scientific knowledge in an era of AI-driven science.

Results: The NLM can rise to new challenges posed by AI by working from its foundations in theories of Information Science and embracing new roles. Three paths for the NLM are proposed: (1) *Become an Authentication Authority* For Data, Information, and Knowledge through Systems of Scientific Provenance; (2) Become An *Observatory* of the State of Human Health Science supporting living systematic reviews; and (3) Become A hub for *Culturally Appropriate Bespoke Translation, Transformation, and Summarization* for different users (patients, the public, as well as scientists and clinicians) using AI technologies.

Discussion: Adapting the NLM to the challenges of the Internet revolution by developing worldwide-web-accessible resources allowed the NLM to rise to new heights. Bold moves are needed to adapt the Library to the AI revolution but offer similar prospects of more significant impacts on the advancement of science and human health.

Key words: National Library of Medicine; artificial intelligence; data; information; knowledge.

Artificial intelligence (AI) is, perhaps, the most significant force of the 21st century and is changing the nature of the scientific endeavor through automated integration, interpretation of scientific data, and even "authorship" of results.[1,2] AI also poses new challenges to the sustainability of scientific endeavors through its generative capabilities, making it difficult to distinguish new knowledge from deliberate fabrications.[3,4]

How should the premier archive of scientific knowledge of human health, namely the National Library of Medicine, adapt to these challenges? The organization is at a turning point: a change in political leadership has resulted in a new NIH director, the need to appoint a new leader for the National Library of Medicine (NLM) in this context, and, most concerningly, a questioning of NLM's fundamental science mission in Congress. As laid out in a recent congressional report from the House Ways and Means Committee Ranking Member, key leaders in Congress are proposing the merger of the NLM with the National Institute of General Medical Sciences and the National Institute for Human Genome Research as part of a broad slate of NIH reforms.[5,6] The Senate also has published a similar call for NIH Institute consolidation.[7]

With so many challenges, the NLM needs more than a few good friends[8] and a strong history of contributions.[9] A clear vision for the NLM's future in a reformed NIH is needed. Does it offer sufficient benefits to warrant its independence as an institute? My suggestion? The NLM should transition from being the *archiver of scientific knowledge (and step back from the idea of managing a massive repository of clinical data*[10]*)* to a more critical role: that of the *protector of the integrity of those scientific processes and AI-powered accelerator of scientific methods that generate knowledge and facilitate its wise application to advance human health*.

The National Library of Medicine organization within the NIH best embodies the fundamental model of Information Science: transforming Data to Information to Knowledge to Wisdom through scientific endeavor.[11,12] Scientific Knowledge is more fragile than we would hope. As the Corona Virus Disease 2019 (COVID-19) pandemic illustrated, it is limited by what we know *at any point in time*. In addition, what is being abstracted in the scientific literature as knowledge is increasingly false, generated through data manipulation and falsification, often using generative AI methods.[13–15] In this setting, dynamic representation of Knowledge in

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networks showing the relationships between facts and the impact of specific evidence may be significant in organizing worldviews to understand when a finding is a novel extension of existing facts and thus supported by evidence, as opposed to the hallucination of a large language model (LLM) or a fabrication of a human with ill intent. Knowledge can sometimes be honestly wrong, limited by the observer's current worldview and measurement limitations. A scientific revolution[16] occurs when a worldview shifts sufficiently that the knowledge postulated upon the sets of facts must be updated to a new worldview or paradigm.[17] Would not it be amazing if AI could help science adapt more rapidly to scientific revolutions by dynamic restructuring of Knowledge?

There is also increasing falsification of scientific evidence using AI and manual methods.[18] The NLM should also move to protect the integrity of scientific data, making it more difficult to falsify through *standards for scientific data provenance*, potentially adapted from work on clinical data provenance.[19] In light of the need to include less reliable sources of evidence, such as pre-print servers, in rapidly evolving fields and growing pressures for scientific "advancement,"[18] the NLM needs to do more to address the growing problem of retractions[13–15] of premature, incorrect and even fabricated evidence in published scientific "knowledge." Surprisingly, many retracted papers are cited for many years after their retractions, leading to the widespread tainting of the literature.[20,21] Suppose we could speed up the unlearning of what is wrong but widely "known" through advancing new distinctions between noise and accurate observations, translating hierarchies of abstraction in structured vocabularies to new worldviews, and improving the integration of both old and new facts into new knowledge. All of this would be widely impractical, except for the advances in AI that can now drive the re-writing of science in the setting of a scientific revolution. Using LLMs and other artificially intelligent general-purpose representations of human knowledge, we can monitor, assess, abstract, and integrate data into summary models, identifying new conclusions and revoking obsolete ones at a previously impossible scale.

Therefore, I propose 3 paths for the development of the NLM in its next strategic plan to address the challenges of AI-enabled science:

Become an Authentication Authority For Data, Information, and Knowledge through Systems of Scientific Provenance: Given the threats to the validity of the scientific literature discussed above, the NLM should move to strengthen the foundations by assuring the appropriate provenance of scientific data and information.[22] One approach to do this might be to become a provenance authority, issuing certificates for scientific data as generated to make falsification impractical. This task could be facilitated by applying blockchain technologies to create incorruptible hash keys of sources and dates of creation for Data and Information,[17] similar to approaches to standards for provenance of clinical data.[23] In addition, it may no longer be possible for the NLM to remain neutral about the quality of published work. PubMed data on articles could include automated application of recognized frameworks to rate the quality of published "knowledge"[24] and its novelty, such as the "edge science" metric described by the NIH's proposed director, Jay Bhattacharya.[25] Instead of returning results by time or search relevance, PUBMED might prioritize the return of *high-quality* results, at least as an option.

Become An *Observatory* of the State of Human Health Science (similar to the WHO Observatory of Human Health[26]): Expanding on the concepts of archives of knowledge about COVID-19 produced by the NLM (LitCOVID[27]) the NLM should move to create a continually expanding series of tools that perform progressively complex integration tasks (scoping reviews and umbrella reviews to systematic reviews with evidence synthesis, to meta-analytical reviews on effect size of specific treatments, to knowledge graphs of critical domains), on problem-focused literature collections, developed collaboratively with other NIH institutes.[28] The end goal should be the movement from the management of knowledge in text-based form to managing knowledge in *standardized computable forms,[29] such as knowledge graphs, sets of decision support rules, and workflow process diagrams, that can be instantly applied and maintained using AI methods.*

Become A Hub for *Individually Tailored Bespoke Translation, Transformation, and Summarization* using AI Technologies: One of the NLM's more important tasks is ensuring medical knowledge is accessible to patients and the public through resources such as MedlinePlus. This requires tremendous efforts to keep this "translated" knowledge current. What if AI could accelerate these efforts through the automatic tailoring of knowledge to patients, cultures, and educational levels?[30] Working from standardized representations of knowledge proposed above, in combination with retrieval augmented generation methods, the NLM's patient-focused resources could begin to use AI's linguistic skills to adapt materials, first with manual review and then, hopefully, automatically.

What skills would the NLM need to acquire to follow these paths? The NLM's employees were trained mainly in a pre-LLM era. Concerted efforts will be required to add new skills to its talent pool. Collaborative approaches to upskilling, such as Communities of Practice,[31] may be necessary to help employees in disparate, perhaps even siloed, Divisions and Sections enhance their skills to address new problems together. The NLM might need to enhance its skills in meta-analysis and collaborate with international organizations' existing efforts. The development of greater expertise in rating the quality of the literature and integration of findings across studies should be a collaborative endeavor with other NIH institutes, potentially led through the chief scientific officers of other institutes and the Director's Office.

What sort of products and timelines could potential supporters in Congress expect? Unfortunately, the goal is not as concrete as many would like. It is the maintenance, in a "post-truth era,"[32] of a system for the continued production of scientific goods for society.[12] But, as NLM actively responds to the challenges posed by AI-powered science, it will find its deserved place in this dynamic time: a place of accelerating the translation of data to information and information to knowledge and actions that impact Health, a place where the NLM can use its unique skills in data science to guarantee the integrity of scientific knowledge against AI fabrications; a place where the NLM functions as an active observatory of the progress of science, integrated through AI, into continuously evolving knowledge products that summarize the state of evidence in a scientific domain, identify gaps and causal mechanisms; and a place where science to promote human health is available to all, including patients and the public.

Author contributions

Leslie Andrew Lenert is the sole author of all content.

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Conflicts of interest

None declared.

Data availability

Not applicable.

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