# Analysis and Implications of the U.S. National Library of Medicine Strategic Plan 2017-2027: A Postprint

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## Abstract

[Purpose/Significance] Through analyzing and interpreting the *National Library of Medicine Strategic Plan: 2017-2027*, this study provides references and insights for the management, services, and long-term development of medical libraries in China. [Method/Process] From the perspectives of both formulation process and strategic content, this paper systematically reviews and analyzes the new strategic plan of the U.S. National Library of Medicine, focusing on its 10-year development goal of building a platform for biomedical discovery and data-driven health, as well as strategic planning and action recommendations across three dimensions: research support, user services, and education and training. [Results/Conclusion] In the context of the new era of the "Healthy China" strategy, to advance the transformation and development of China's medical libraries, emphasis should be placed on the following aspects: developing scientific strategic plans, prioritizing the development trends and applications of new technologies, fostering the establishment and maintenance of cooperative relationships, and promoting the socialization of health information services.

## Full Text

## Preamble

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**Interpretation and Enlightenment of *National Library of Medicine Strategic Plan 2017–2027***

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## Abstract

[**Purpose/Significance**] This study analyzes and interprets the *National Library of Medicine Strategic Plan 2017–2027* to provide reference and enlightenment for the management, services, and long-term development of medical libraries in China. [**Method/Process**] The new NLM strategic plan was examined from two perspectives: its formulation process and strategic content, with particular emphasis on its 10-year development goal of building a platform for biomedical discovery and data-powered health, as well as its strategic plans and action recommendations across three dimensions: research support, user services, and education/training. [**Result/Conclusion**] Against the backdrop of the "Healthy China" strategy in the new era, to promote the transformation and development of medical libraries in China, attention should be paid to the following aspects: developing scientific strategic planning, emphasizing the evolution trends and applications of new technologies, focusing on establishing and maintaining cooperative relationships, and promoting the socialization of health information services.

**Keywords:** National Library of Medicine; strategic plan; enlightenment; data science; open science
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The National Library of Medicine (NLM) is the world's largest biomedical library, leading globally in the collection, organization, and dissemination of biomedical information. Its fundamental mission is to advance biomedical research, support healthcare and public health, and promote healthy behaviors. A review of NLM's history reveals that long-term planning has played a crucial role in its orderly and healthy development [1]. Influenced by the computer and information technology revolution, NLM began formulating long-range plans in the 1980s. As the social information environment and library development trends evolved, NLM developed a series of long-range plans, as shown in Table 1 . Domestic scholars have consistently emphasized the introduction and interpretation of NLM's long-term plans. Peng Junling [2] translated and compiled the main content of *NLM Long Range Plan (2000–2005)* but did not further discuss its implications and practical value. Later, Zhang Shijing et al. [3] and Ren Huiling and Hu Dehua [4] introduced and analyzed *Charting the Course for the 21st Century: NLM's Long Range Plan 2006–2016* and discussed its implications for the development of medical libraries in China. However, more than 10 years have passed since the previous version, during which science and technology and the social information environment have undergone significant changes. Therefore, analyzing and interpreting the new *Plan* holds valuable reference significance for the future development of medical libraries in China.

## 1. The Formulation Process of the Plan

In recent years, the internal and external environment of libraries has changed dramatically, with emerging technologies such as cloud computing, mobile internet, internet of things, big data, and artificial intelligence, as well as the rise of data science and open science, exerting broad and profound impacts on library services and management. Comparatively, biomedical libraries need to manage large amounts of biomedical-related data, so changes in the technological and other external environments may have even more significant impacts on them [7]. It is against this backdrop that NLM, based on environmental scanning, needs assessment, expert consultation, and field research, formulated the new *Plan*. The entire formulation process, from initiation, drafting, review to release, took more than a year, as shown in Figure 1 [Figure 1: see original paper]. In September 2016, the NLM Board of Regents established a Strategic Planning Subcommittee, authorizing it to take full responsibility for and guide the strategic planning process. Subsequently, NLM initially identified four strategic directions for the next decade: (1) advancing data science, open science, and biomedical informatics; (2) advancing biomedical discovery and translational science; (3) supporting public health and personal health; and (4) strengthening collection development to support data-driven strategies.

During the strategic planning process, to fully incorporate the wisdom and suggestions of domain experts, the general public, and NLM staff, NLM adopted a series of measures including visits and surveys of training programs, online solicitation of opinions, organization of expert working groups, and surveys of NLM staff. Specifically: (1) To clarify the scope and characteristics of training programs, NLM visited and surveyed 10 training programs and held discussion forums for different stakeholders (including program staff, managers, and trainees). (2) NLM published a request for information on the official website of the National Institutes of Health (NIH), receiving 111 responses from librarians, researchers, public health experts, emergency responders, nurses, clinicians, NLM staff, informatics experts, data scientists, historians, associations, and the general public. Additionally, previous online opinion solicitations and survey reports also formed an important foundation for the *Plan*. (3) Around the four strategic directions, NLM organized four external expert working groups covering various institutions and disciplinary fields, totaling more than 100 experts. Subsequently, NLM established an internal expert working group to sort out, analyze, discuss, and synthesize the discussion reports from the external expert working groups. (4) In addition to online channels, NLM also set up suggestion boxes in office spaces, receiving 112 anonymous suggestions from staff, and learned about staff perceptions and needs on topics such as data science, collection development, global health, partnerships, organizational restructuring, human resource development, media and communication, and organizational culture through all-staff meetings. Finally, in December 2017, the *Plan* was officially released.

## 2. Interpretation of the Plan's Content

The new *Plan* clarifies NLM's strategic goal for the next decade: to build NLM into "a platform for biomedical discovery and data-powered health." This overarching goal is broken down into three sub-goals at the levels of research support, user services, and education/training, with detailed action plans and recommendations proposed for each sub-goal, as shown in Table 2 .

### 2.1 Accelerating Discovery and Improving Health Through Data-Driven Research Tools

**2.1.1 Strengthening Collection Development** Collection development is the foundation and guarantee for NLM to provide public health information services and research support. The fundamental goal is to create a comprehensive platform that aggregates various types of information resources (including traditional print resources and digital collections) to provide data foundations and drivers for biomedical discovery and health improvement. The *Plan* states that collections of information resources, regardless of whether they are physical or digital, are "fuel for thought, knowledge, insight, and progress." When heterogeneous, relevant information collections can be searched, integrated, shared, aggregated, and analyzed, the value of individual collections increases exponentially. Overall, NLM's collection development follows principles of modernization, equity, and diversity.

**(1) Modernization.** To respond to changes in science and technology, the information environment, and user needs, NLM will advance the modernization of collections and services, including: developing new methods for automated indexing to improve the efficiency of data curation and collection management; improving existing information representation methods; strengthening the connection, integration, and interoperability of internal and external resources; and designing systems according to FAIR (findable, accessible, interoperable, reusable) principles to achieve findability, accessibility, interoperability, and reusability of collections.

**(2) Equity.** NLM pays close attention to health disparities among different social groups and plays an irreplaceable role in the development and provision of related resources. To support research on health disparities, a large number of indicators or data related to health disparities have been incorporated into the scope of collection development, including not only demographic characteristics such as gender, age, race, and ethnicity, but also biological, genetic, social, behavioral, and environmental factors. NLM's efforts in reducing health disparities and promoting information equality and social equity have contributed to NIH's "Minority Health and Health Disparities" strategic plan [8].

**(3) Diversity.** NLM places great emphasis on the collection, organization, and dissemination of different types of biomedical information resources. In addition to traditional literature resources, genomic data, research data, standards, data science tools, clinical data, health status indicators of residents and communi-

ties, scientific communication, and health information for the public are also included in the scope of NLM's collection development, as shown in Table 3 .

**2.1.2 Advancing Biomedical Informatics and Data Science Research** As a platform for data-driven discovery, NLM plays an important role throughout the entire lifecycle of scientific research, from inspiring scientific ideas to providing research tools, from predicting research directions in biomedicine and health care to improving the efficiency of scientific communication and dissemination. Through collection development, NLM will establish a "System of Digital Research Objects" covering papers, datasets, algorithms, analytical models, visualization tools, reference standards, etc. Each research object will have a unique identifier, and the association and fusion of digital objects may generate new knowledge and value while also bringing enormous computational and scientific challenges. Overcoming these challenges requires research and development in biomedical informatics and data science, including innovation in data curation, data mining, analysis, visualization, data modeling, and knowledge generation [9].

The *Plan* identifies five major research challenges in biomedical informatics and data science: (1) How to effectively curate the massive digital research objects generated in biomedical research, healthcare, public health, and consumer health fields, and improve operational efficiency and accelerate scientific discovery speed through automated and autonomous data curation methods. (2) Moving beyond statistical and visualization-based data analysis methods to conduct deeper semantic mining of multi-source heterogeneous data using cutting-edge data science technologies such as artificial intelligence, natural language processing, and deep learning. (3) Research on "computable biomedical knowledge" (such as inference, prediction, and decision analysis models, or practice guidelines represented as coded digital objects), which is an increasingly important supplement to human-readable knowledge in books and journals. (4) Defining the structure and function of "executable articles," which are equivalent to interactive repositories where resources can connect and communicate with each other, achieving transformation and transition from data to knowledge and from knowledge to action. (5) Formulation and solution of data-driven questions. Rich data resources provide opportunities for basic research in the biomedical field, and NLM will collaborate with NIH scientists to propose research questions and identify valuable solutions.

**2.1.3 Cultivating Open Science Policies and Practices** Open science is a movement to make the process and outputs of scientific research open and shared with different social levels including researchers, amateurs, and the general public. It overcomes the closed nature of traditional scientific culture and highlights the concepts of freedom, openness, cooperation, and sharing. Wu Jianzhong, Director of the University of Macau Library, considers the open movement one of the ten hot topics affecting the future development of libraries [10], and promoting open data to assist open science is an important measure

for libraries to enter a new era of qualitative development [11]. In June 2016, the International Federation of Library Associations and Institutions (IFLA), the European Bureau of Library, Information and Documentation Associations (EBLIDA), and the Association of European Research Libraries (LIBER) jointly issued a statement calling on the global library community to jointly establish an open science system [12]. Based on multi-angle exploration of the concept, connotation, and ideas of open science, Liu Guifeng et al. constructed an open science system consisting of open science policies, open access, open data, open resources, open peer review, and open educational resources [13]. The importance of libraries in the open science system is beyond doubt.

In the development environment of open science and open scholarship, NLM positions its role and contribution at the intersection of biomedicine, information science, data science, and library and information science, generating new knowledge, services, and mechanisms [14]. NLM will vigorously advocate and actively practice the concept of open science, making the process and products of scientific research (publications, research data, software, etc.) more accessible. NLM will continue to develop tools, systems, and services that support open science, such as the biomedical literature database PubMed, the expandable and dynamic Medical Subject Headings (MeSH), the Unified Medical Language System (UMLS), and the clinical trial database ClinicalTrials.gov. However, the open science advocated by NLM is based on the protection of privacy, confidentiality, security, and certain proprietary rights (such as intellectual property rights). Therefore, developing technologies and systems that provide access restrictions is also one of NLM's development directions. Additionally, NLM will play an important role in the formulation and implementation of relevant policies on data sharing, privacy protection, and informed consent, helping to incentivize open science practices that comply with legal and ethical norms and alleviating the complex contradictions between freedom in biomedical research and patient privacy.

**2.1.4 Creating a Sustainable Institutional, Physical, and Technical Infrastructure** To build NLM into a platform for data-driven discovery and data-driven health, NLM also needs to make adaptive changes to its physical, organizational, and technical environments. First, in terms of the physical environment, as a national biomedical library bearing the responsibility of preserving the biomedical heritage, NLM needs adequate, purpose-specific space to accommodate and support its physical and digital collections to ensure long-term preservation and access. Second, in the organizational environment, to coordinate with NLM's data science and open science activities, NLM's organizational structure and institutional settings also need to be adjusted accordingly. For example, NLM launched the "Data Science and Open Science Program," managed and coordinated by NLM's Office of Health Information Programs Development [15]. Finally, at the technical environment level, NLM should strengthen its technical infrastructure, ensure the capacity and reliability of data centers and computing platforms, try innovative computer and network

solutions, and address key technical challenges such as authentication and authorization, compliance with data access and reuse, dataset security, and session permissions.

### 2.2 Enhancing and Expanding User Services Through Strengthened Dissemination and Engagement Pathways

**2.2.1 Understanding Users and Their Information Needs** NLM's user groups are extremely broad, including librarians, researchers, policymakers, teenagers and their parents, patients, the general public, clinicians, pharmaceutical companies, and public health laboratories. Moreover, each user group differs in habits and preferences, health status, data literacy, information-seeking motivations, content of information needs, and behavioral patterns. Therefore, to fully understand users and their information needs and to enhance and expand user services, the *Plan* makes the following recommendations: (1) Use principles of human factors engineering, user experience, and human-computer interaction to guide the design and delivery of service content and models; (2) Further enhance NLM's visibility among intended audiences nationwide and globally, and collaborate with the National Network of Libraries of Medicine (NNLM) to expand the scope of health information services; (3) Adhere to a people-centered, equitable service philosophy, focusing on improving health information services for socially vulnerable groups to reduce health disparities, and promote user engagement and service access for disadvantaged groups by enhancing their awareness and understanding of health information resources, understanding their information needs, providing convenient access channels, and cultivating their ability to use information resources.

**2.2.2 Improving User Awareness, Understanding, and Trust of Health Information Resources and Services** NLM is committed to becoming the primary source of high-quality health information recognized by users and a trusted health information service provider that can solve health problems and meet biomedical data needs. Today, millions of users use NLM's information services daily, and the biomedical and data health information resources provided by NLM are increasingly important for biomedical discovery and contemporary healthcare. However, users still lack sufficient awareness, understanding, and trust of NLM's resources and services. To address this, the *Plan* proposes recommendations including launching public awareness campaigns, promoting the branding of NLM resources, strengthening data quality management controls, and cultivating best practices in health data management.

**2.2.3 Supporting Research Related to Biomedical Data, Health Information Access Methods, and Dissemination Strategies** NLM will continue to support and conduct informatics and data science research, including: (1) Understanding how health information searches are triggered, how information is used, and how questions are posed and answered; (2) Using data visualization, human-computer interaction, natural language processing, virtual reality,

and augmented reality technologies to promote innovation in information access methods and information delivery strategies; (3) Designing user interfaces and query systems that can be conveniently accessed and reflect personal information needs and behaviors; (4) Conducting research to solve problems of literacy, computational ability, and information operability to meet the health information needs of different users (especially vulnerable groups such as chronic disease patients, immigrants, the elderly, and people with disabilities).

**2.2.4 Enhancing Information Distribution and Service Delivery** To further enhance and expand user services, the *Plan* proposes the following action recommendations for enhancing health information distribution and service delivery: (1) Support users' efficient and convenient access to information service platforms through multiple user-centered interactive interfaces; (2) In addition to designing new methods for information query, NLM will also develop push models that can predict user needs and ensure personalized and real-time updating of query results; (3) Explore the application of different input and output methods such as voice, image, and virtual reality applications in health information distribution and delivery services; (4) Identify problems and obstacles in the information service process through usability experiments to optimize user experience and help users find information faster; (5) Given the broad user groups and usage scope of NLM resources, NLM will continue to provide multiple service delivery platforms, including application programming interfaces, mobile devices such as smartphones, social media, web-based applications, and standalone applications that can operate without internet access; (6) Pay attention to the interaction between digital devices and NLM service systems.

### 2.3 Conducting Education and Training for Data-Driven Research and Data-Driven Health

**2.3.1 Expanding and Strengthening Biomedical Informatics and Data Science Research Training** Cultivating professionals for biomedical, clinical, and translational research, public health, medical informatics, and other fields is one of NLM's important missions. To this end, NLM has established a rich education and training system: (1) In-house training, including postdoctoral programs in bioinformatics and computational biology, graduate programs in library and information science, and research programs for visiting scholars. (2) University training funded by NLM. NLM funds training at universities such as Stanford, Yale, and Harvard, covering bioinformatics, clinical informatics, public health informatics, and genomic informatics. (3) Training conducted in cooperation with other federal agencies and social organizations. For example, NLM collaborates with the Agency for Healthcare Research and Quality (AHRQ) to provide medical informatics training for clinicians and nursing care personnel.

With the diversification of sources, structures, and types of digital information

resources in the biomedical field, as well as the exponential growth of data scale, traditional education and training content and methods urgently need to be transformed. The *Plan* points out that in the era of biomedical big data, NLM needs to cultivate a new generation of biomedical researchers and data scientists. To this end, NLM will expand and supplement existing education and training content, such as strengthening the concepts of biomedical big data security protection and privacy management, enhancing abilities in data aggregation, data visualization, data analysis, and dynamic real-time data curation, exploring innovative methods for scientific data management, dissemination, and analysis, and paying attention to fields such as computing in context and consumer health informatics. Additionally, NLM will organize some extended short-term training programs, forming an interdisciplinary team composed of scholars from different fields such as biomedicine, information science, computer science, and data science to generate next-generation artificial intelligence and machine learning through ideological integration and viewpoint collision.

**2.3.2 Strengthening Education and Training in Data Science and Open Science** In the internet and digital media environment, powerful search engines, websites, and databases provide instant access to massive information resources, but also cause patients, clinicians, researchers, and the general public to get lost in unlimited potentially relevant resources. At the same time, the open science movement is intensifying globally, and data sharing and reuse have become the new normal in biomedical research. The scientific community and researchers need help from NLM and data scientists to ensure that research data is effectively managed throughout the entire research lifecycle. In addition, new technologies such as virtual reality and artificial intelligence continue to emerge, the social information environment in which libraries are situated and the service needs of user groups continue to change. Therefore, to achieve the overall goal of data-driven health and data-driven research, NLM must cultivate a new generation of librarians and information experts who can adapt to future development. It is necessary to strengthen education and training in scientific data management, data science, and open science to establish a strong workforce that can solve biomedical data science problems.

It is worth noting that the network and digital environment has spawned new educational forms such as online distance education and computer-mediated learning, and the open movement has also provided a large number of open educational resources. To expand training programs, NLM will cooperate with educational institutions, MOOC platforms, and online education providers to carry out a series of online training courses, including learning and use of internet applications such as web search engines and social media.

**2.3.3 Increasing Workforce Diversity** Workforce diversity refers to diversity in personnel composition, ideas, and methods, which is consistent with IFLA's concept of inclusiveness. NLM is committed to building a strong, diverse workforce (including librarians, project management and executive staff,

volunteers, etc.) that strives for research support services and public health services. To this end, the *Plan* provides the following specific recommendations: (1) The workforce composition should include different racial and ethnic groups, people with disabilities, and people with poor economic or educational conditions; (2) Fully consider the selection, organization, and implementation of training content to ensure the completeness and reliability of courses in training programs; (3) Support and cultivate training programs for high school and college students to enhance their interest and attention in careers such as health information technology, medical libraries, and data science; (4) Cooperate with social groups such as minority service alliances to increase the interest and participation of underrepresented groups in NLM training programs.

**2.3.4 Engaging the Next Generation and the General Public, and Enhancing Their Data Literacy** To cultivate the next generation of biomedical informatics researchers, informatics experts, and data scientists, NLM will cooperate with educational institutions to determine the required knowledge levels and professional skills of professionals, develop programs that can stimulate children's and teenagers' interest in Science, Technology, Engineering, and Mathematics (STEM), and design targeted educational resources for students from elementary school to university. In addition to children, teenagers, and student groups, NLM's education and training scope also extends to the general public. NLM will cooperate with communities, educational institutions, public libraries, and other social organizations to conduct relevant lectures and training to enhance the public's health literacy and data literacy capabilities, including the acquisition, evaluation, and utilization of health information resources, the application and promotion of health information technology and electronic health services, understanding and awareness of NLM collection resources and services, and learning and use of internet applications such as web search engines and social media.

## 3. Implications of the Plan

In summary, this study analyzed and interpreted NLM's new *Plan* from the perspectives of its formulation process and strategic content. In terms of the formulation process, the *Plan* has the following characteristics: (1) A dedicated strategic planning committee and working groups were responsible; (2) Adequate preliminary research and preparation work; (3) Maximizing the incorporation of wisdom from domain experts and the public; (4) Emphasizing inheritance, reference, supplementation, and development between strategic plans; (5) Examining future development prospects with strategic vision and broad perspective. These characteristics reflect the scientific nature of the *Plan* and are aspects that can be learned from in the strategic planning process of medical libraries in China.

In terms of strategic content, the new *Plan* strongly emphasizes "data-driven" and "platform construction." These two concepts are evident in the title of

the *Plan* and run throughout its entirety, reflecting distinct characteristics of the times. It is worth noting that the concepts of "data-driven" and "platform construction" in the new *Plan* coincide with Zhang Xiaolin's discussion on the "data era" and "from libraries to knowledge service platforms" [16]. Both the formulation process and strategic content of NLM's new *Plan* have enlightening significance for the transformation and development of China's medical library community in the new era.

### 3.1 Developing Scientific Strategic Planning

Library strategic planning is the thinking process and framework through which libraries determine their mission, vision, goals, strategies, and implementation plans for the future. It is of great significance for libraries to respond to environmental changes, guide future construction, and achieve transformation and development [17]. NLM, which leads the development trend of international biomedical libraries, has always attached great importance to strategic planning. In contrast, medical libraries in China lag seriously behind in both theory and practice of strategic planning. In terms of theory, searches in CNKI and Wanfang databases reveal that domestic research related to "medical library strategic planning" mostly discusses implications for domestic medical libraries based on foreign medical libraries' strategies (mainly NLM). In terms of practice, comprehensive investigations and analyses of multiple channels including Baidu and other search engines, official websites of medical libraries (Chinese Academy of Medical Sciences Library (Institute of Medical Information), Peking University Medical Library, Tongji Medical College Library of Huazhong University of Science and Technology, etc.), and academic databases show that strategic plans of domestic medical libraries are relatively rough, scattered, and have not formed systematic strategic documents, nor have they normalized the strategic planning process. Moreover, they lack strong strategic planning institutions and sufficient strategic planning awareness. In China's medical library system, the Chinese Academy of Medical Sciences Library (Institute of Medical Information) is a national-level medical information research center and medical information resource guarantee and service center, undertaking important functions of the national medical library. Therefore, the author believes that a relatively feasible strategic planning development path might be for the Chinese Academy of Medical Sciences Library to take the lead, jointly with resources and forces from institutions such as Peking University Medical Library and the PLA Medical Library, to formulate a strategic plan that both conforms to the current situation of Chinese medical libraries and adapts to international development trends. Of course, associations and societies such as the Medical Library Branch of the China Library Association should also undertake corresponding organization and coordination work.

### 3.2 Emphasizing the Evolution Trends and Applications of New Technologies

The information civilization brought about by the information revolution has led new changes in libraries, creating new spaces and new forms of library services, greatly improving the efficiency and effectiveness of library services. The accompanying new technologies have driven libraries through four waves of innovative development: library automation, digital libraries, internet (mobile internet), and artificial intelligence [18]. The role of new technologies in the development and service innovation of medical libraries is self-evident. Taking NLM as an example, information and communication technologies have always played an important role in NLM's strategic planning and transformation development, and NLM established the National Center for Biotechnology Information (NCBI) as early as 1988. In NLM's latest *Plan*, key technologies of focus include: cloud computing, internet of things, big data, linked data, knowledge bases, data mining, data visualization, knowledge computing, context computing, preprints, artificial intelligence, natural language processing, deep learning, human-computer interaction, virtual reality, augmented reality, electronic health records, health tracking, wearable technology, and cybersecurity technology. NLM's *Plan* and its practices provide valuable reference and enlightenment for the future development of medical libraries in China. Artificial intelligence will reshape libraries, bringing new changes to all aspects of libraries including information resource construction, services, librarians, buildings and environment, and library management [19]. In the context of "Internet +," medical libraries can use social media technologies such as Weibo and WeChat to carry out public health information services such as medical news release, health knowledge push, and health literacy education, or provide personalized information services and guide collection development based on analysis of digital traces, offline records, and feedback comments generated by users during their use of library services.

### 3.3 Focusing on Establishing and Maintaining Cooperative Relationships

Cooperation is a major trend in international library development and a key to activating social resources to promote the healthy and sustainable development of libraries [20]. In addition to establishing and improving internal coordination among various departments and project teams, NLM also attaches great importance to establishing and maintaining external cooperative relationships. Among them, the National Network of Libraries of Medicine (NNLM), led and created by NLM, is recognized as an exemplary medical library consortium in the industry, including approximately 6,500 member libraries such as public libraries, medical school libraries, hospital libraries, research institute libraries, and some small local libraries. It plays an important role in the sharing and utilization of medical resources and expanding the scope of socialized services. Additionally, in terms of collection development and data integration platforms, in

addition to NLM's internal resources, NLM will establish extensive cooperative relationships with stakeholders such as the World Health Organization, other NIH departments, the Food and Drug Administration (FDA) and other federal agencies, electronic health record vendors, clinical care institutions, search engine companies, and health information providers to connect various types of biomedical resources (including research data, standards, clinical data, and consumer health information) from inside and outside NLM and around the world. In terms of data-driven knowledge discovery and research support services, NLM will establish exchange and cooperation mechanisms between biomedicine and clinical research, biomedical informatics, data science, computer science, and library and information science to promote interdisciplinary integration, knowledge fusion, and service innovation. In terms of talent cultivation and public education, NLM will cooperate with federal agencies such as the U.S. Department of Education, higher education institutions, K-12 educational institutions, online education platforms, social organizations, public libraries, and communities to promote the cultivation of professional talents such as data scientists and the improvement of public health literacy and data literacy capabilities. China's medical libraries have mainly taken measures such as the Medical Library Branch of the China Library Association, the National Medical Literature Information Center of the China Academic Library & Information System (CALIS), and the Shanghai Jiao Tong University Medical Library Alliance to promote cooperation, but overall, the breadth, depth, and forms of cooperation need to be further strengthened.

### 3.4 Promoting the Socialization of Health Information Services

The *Plan* attaches great importance to the outreach and socialization of NLM's health information services (including health information access and use, health education and training, and broad public participation), mainly reflected in the following aspects: (1) The MedlinePlus website enables the general public to quickly and conveniently query needed health information without time and location constraints, and its health information is comprehensive, reasonably classified, easy to search, easy to understand, vivid, intuitive, and of high quality and authority [21]. (2) In addition to online health information services, NLM also carries out relevant publicity and promotion work through nationwide touring exhibitions and cooperative projects with NNLM and grassroots communities to improve the general public's understanding, awareness, and use of NLM's health information resources and services. (3) To reduce health disparities and health inequalities, NLM continuously launches service projects tailored to the health status and living environment of vulnerable groups such as the elderly, women, children, immigrants, people with disabilities, and African Americans with low socioeconomic status, to targeted improve their health literacy, including distinctive projects such as the Native American Tribal Health Information Services Outreach Program, Rural Health Outreach, and HIV/AIDS Information Outreach [22]. (4) NLM strongly supports research related to user information needs, human-computer interaction, and health information communication to

optimize user experience and promote health information dissemination.

With the formal elevation of "Healthy China" to a national strategy, policies emphasizing health equity, community health, and building online health service platforms have been introduced successively [23]. In recent years, as the national-level medical library, the Chinese Academy of Medical Sciences Library (Institute of Medical Information) has actively carried out practical applications of public health knowledge services, continuously exploring implementation paths for public health knowledge popularization services, such as designing and building the "China Public Health Network" [24] and constructing health knowledge bases and public health knowledge service platforms [25]. To further promote the socialization of health information services of medical libraries in China, efforts can be made in the following aspects: providing information training services for community doctors and "information-poor" populations, promoting information co-construction and sharing, and providing information navigation services and personalized information services for society.

With the evolution of digitalization, datafication, and computational trends, as well as the development of open data and open science movements, concepts such as data-driven value discovery, data-driven innovation, and knowledge service platforms have gradually penetrated the library field. Medical libraries are at the intersection of highly developed biomedicine, increasingly mature library and information science, and the emerging field of data science, as well as at the forefront of transformation. Analyzing and exploring the formulation and implementation of the new *Plan* of the U.S. National Library of Medicine has important reference and enlightenment significance for the healthy and sustainable development of China's medical library community in the new environment and new era. Currently, compared with public libraries and university libraries, research and practice related to medical libraries in China are relatively weak. With the integration of the Healthy China strategy and library and information service innovation, research and practice related to medical libraries will enter a period of rapid development, which the author will continue to follow.

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*Note: Figure translations are in progress. See original paper for figures.*