

# 2016

## Programs and Services





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# Programs and Services

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Fiscal Year  
**2016**



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## MESSAGE FROM THE DIRECTOR

I am honored and delighted to introduce the report covering the National Library of Medicine's programs and services for fiscal year 2016, my first as director.

I took the oath of office just two weeks before the year's end, so credit for the accomplishments detailed in these pages belongs to Betsy Humphreys, who held the reins for 16 months following former director Dr. Donald Lindberg's retirement. Betsy's longstanding familiarity with every nook and cranny of NLM and every aspect of its work eased my transition and ensured continued progress across the Library. As this report shows, NLM thrived under her leadership.

NLM exists first and foremost to support discovery. Whether that comes through mapping public health issues, developing computational tools, combating antimicrobial resistance, tracing pathogen outbreaks, or funding research, NLM staff work to improve our nation's health. We do not deliver direct patient care, but our bibliographic resources, our genomic data, our chemical and drug information, and our standards and terminologies come together to ensure that information needed by health professionals at the point of care, by patients and their families at times of decision, by researchers in the lab, and by first responders when disaster strikes is ever current and reliably available.

The Library's reach grew this year thanks to new and continued partnerships. We received a generous gift from the DeBakey Medical Foundation to enhance access to the Michael E. DeBakey archives and associated collections held at NLM. We awarded five-year cooperative agreements to eight institutions to serve as Regional Medical Libraries within the National Network of Libraries of Medicine, with five of them also taking on roles as National Coordinating Offices. With the Friends of the National Library of Medicine and Research!America, we sponsored a conference on improving the reproducibility and transparency of biomedical research. And the Friends, together with the American Medical Informatics Association, also sponsored the inaugural Donald Lindberg and Donald King Lecture, which was delivered by Stanford professor Russ Altman, PhD.

We unveiled the portrait of Dr. Lindberg and his wife, Mary, this year, a portrait that prominently hangs near the director's office. After 30-plus years of service to this Library, it seems fitting that they continue to watch over the activities on the Mezzanine.

And what activities they are! The talent, commitment, and creativity of leadership and staff—so evident on the following pages—give me confidence that we can build upon this year's achievements to develop the resources needed to help meet future challenges within health care and biomedical research.

A handwritten signature in cursive script that reads "Patricia Flatley Brennan".

Patricia Flatley Brennan, RN, PhD  
Director





## NATIONAL LIBRARY OF MEDICINE LISTER HILL CENTER



# Brennan Sworn in as NLM Director

Patricia Flatley Brennan, RN, PhD, publicly took the oath of office as the 19th leader of the National Library of Medicine on September 12, 2016, in a ceremony officiated by NIH Director Francis Collins, MD, PhD.

Attended by about 200 colleagues and friends—with over 200 more online—the event also featured tributes by NLM Deputy Director and former Acting Director Betsy Humphreys and by Dr. Robert Greenes, Chair of the NLM Board of Regents.

Brennan is the first woman and first nurse appointed as director and only the fourth person to serve in that role since the institution was officially renamed the US National Library of Medicine 60 years ago.

Humphreys' opening remarks set a warm tone for the afternoon, as she set the stage for Dr. Brennan's largely future-oriented presentation by looking back at the Library's 180-year history, from the groundbreaking leadership of Lt. John Shaw Billings through Dr. Donald Lindberg's innovative tenure.

Following a sustained round of applause, Brennan began her remarks by introducing herself—both personally and professionally—describing how the second oldest child in a large Irish-Catholic family went on to a career



that blended nursing and industrial engineering in research focused on empowering patients and their caregivers.

Using slides and videos, her presentation drew on the Library's history and celebrated its present to focus on its future. "We are here today to anticipate the third century," she told the assembled guests, noting the importance of looking outside the Library to forecast the health challenges we must help solve.

"The National Library of Medicine is about discovery," Brennan said, and "bringing information that's actionable, meaningful, understandable, and useful to everyone."

She talked about taking a life-span approach to understanding disease, creating learning systems that better leverage data to manage health, and enabling improved treatment and better self-management by harnessing technology. "The future is a future of data," Brennan predicted. "We need to be ready."

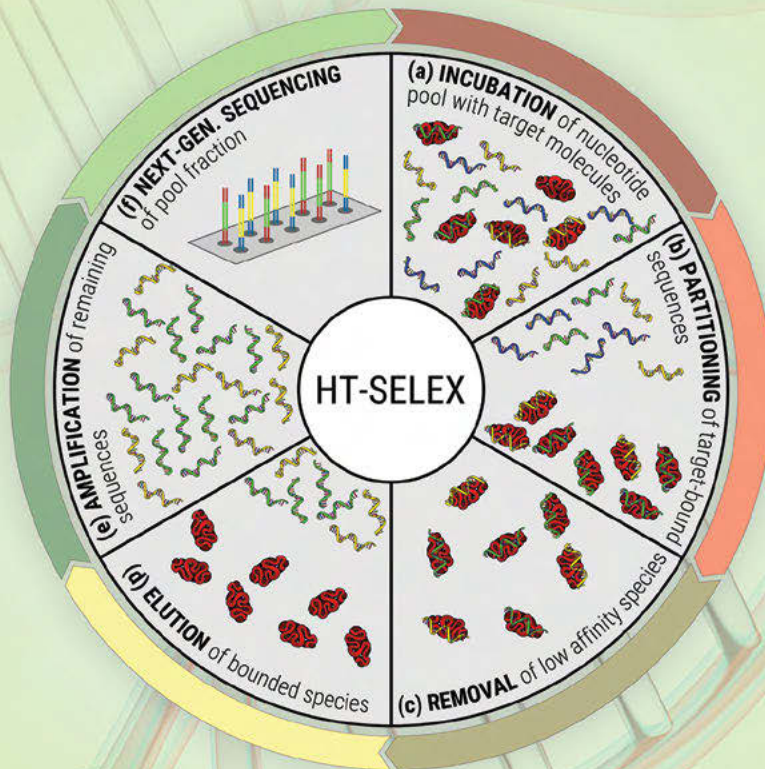
Dr. Collins followed Brennan's presentation with brief remarks before delivering the oath of office. He shared, based on the broad diversity of programs and disciplines in the NLM portfolio, how challenging it was to find all the attributes needed to lead NLM in a single person.

Dr. Collins called Dr. Brennan "ideally suited to lead the NLM in the era of precision medicine" and praised her for having a worldview that "is both nuanced and optimistic."

For the oath of office, Brennan used a commemorative bound copy of the US Constitution once owned by Congressman Claude Pepper, author of the legislation creating the National Center for Biotechnology Information. Her older sister, Jean Flatley McGuire, PhD, held the historic book during the oath.

Before coming to NLM, Brennan had served as the Lillian L. Moehlman Bascom Professor at the School of Nursing and College of Engineering at the University of Wisconsin-Madison. She also led the Living Environments Laboratory at the Wisconsin Institutes for Discovery, which develops new ways for effective visualization of high dimensional data.

Brennan received a master of science in nursing from the University of Pennsylvania and a PhD in industrial engineering from the University of Wisconsin-Madison. Following seven years of clinical practice in critical care nursing and psychiatric nursing, Brennan held several academic positions at Marquette University and Case Western Reserve University before landing at the University of Wisconsin-Madison.



## AptaTRACE Turns Data into Insights

Developing algorithms capable of transforming “big data” into information is one of the key goals of Teresa Przytycka, PhD, a researcher in NLM’s National Center for Biotechnology Information (NCBI). Przytycka leads a group of NCBI researchers who did just that in 2016 with a new software tool called AptaTRACE.

AptaTRACE can accelerate drug development by helping scientists identify molecules that bind with high precision to targets of interest.

AptaTRACE is used with a laboratory technique called HT-SELEX, for High-Throughput Systematic Evolution of Ligands by Exponential Enrichment, that identifies aptamers.

Aptamers are short RNA or DNA molecules capable of binding—with high affinity and specificity—to diverse biological targets. This precision arises from an aptamer’s sequence and structure, which match up to the biochemical characteristics of the target’s surface like a uniquely paired puzzle piece.

Possible targets of aptamers include small organic molecules, proteins or protein complexes, virus surfaces, and entire cells. This broad range of

targets makes aptamers candidates for a variety of applications, ranging from molecular biosensors to drug delivery systems to antibody replacement.

The original SELEX process (Systematic Evolution of Ligands by Exponential Enrichment) has been the typical method for identifying aptamers since 1990. SELEX works by keeping the RNA or DNA sequences that bind to the target and washing away the rest. Scientists then use polymerase chain reaction (PCR) to make multiple copies of those bound sequences.

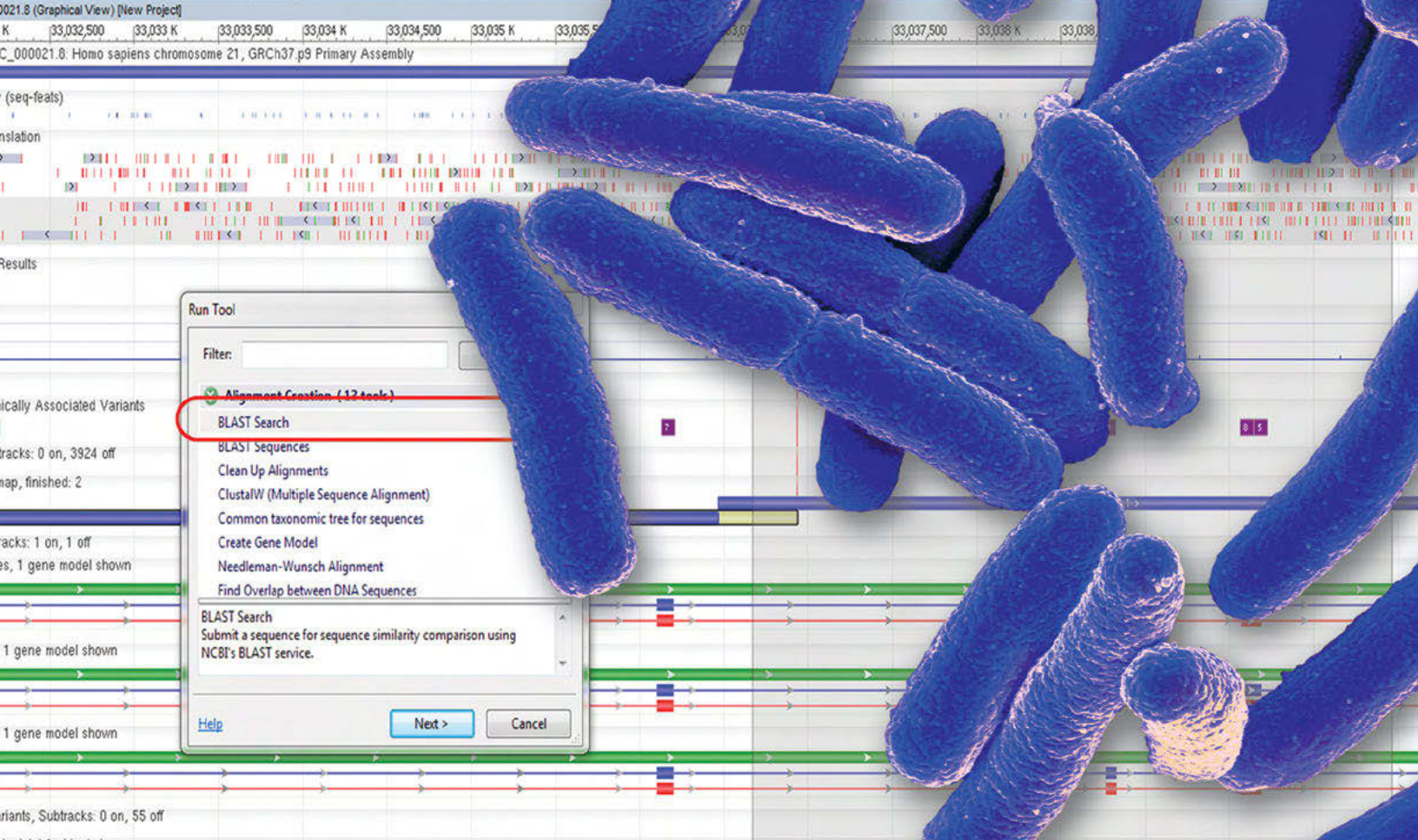
High-throughput, or HT-, SELEX multiplies how many sequences can be analyzed with each round of washing and PCR, upping that count to the millions and with it, dramatically increasing the number of aptamers researchers have identified.

Enter AptaTRACE, which transforms that sizable data into usable information.

A computational tool, AptaTRACE identifies the common features (or “motifs”) among the sequences that bind. And because it analyzes the full scope of sequencing data from many selection rounds, AptaTRACE can enrich researchers’ understanding of why some molecules bind and others do not.

Such understanding allows scientists to take fuller and faster advantage of the HT-SELEX-identified aptamers, for instance modifying them into drug delivery systems targeting specific cells.

AptaTRACE is the result of a collaboration between Przytycka’s group and researchers from the Beckman Research Institute of City of Hope, led by John Burnett, PhD, and from Freiburg University, led by Rolf Backofen, PhD. It is one of a suite of AptaTools that Przytycka’s group has developed for work with HT-SELEX data, promising more data-derived insights, more precision in medications, and better health.



# Genomic Data Combats Antibiotic Resistance, Foodborne Disease

Antimicrobial resistance is one of the most pressing health issues facing the United States today. Each year two million Americans become infected with antibiotic-resistant bacteria, and more than 23,000 of them die as a direct result of the infections, according to estimates from the Centers for Disease Control and Prevention (CDC). Antimicrobial resistance also substantially impacts the economy, resulting in an estimated \$20 billion in excess direct health care costs annually, as well as an additional \$35 billion in lost productivity.

NLM's National Center for Biotechnology Information (NCBI) joined the federal effort to combat this major public health problem by creating resources to help researchers identify the genetics behind antibiotic resistance.

NCBI developed two databases: the National Database of Antibiotic Resistant Organisms (NDARO) and a curated database of genes that confer or contribute to antibiotic resistance.

NDARO resulted in part from a collaboration with the CDC, which sequenced its samples of bacteria that have shown drug resistance and

established their drug resistance profiles. These profiles, called antibiograms, show the sensitivity or resistance of a bacterial strain to different antibiotics.

The NCBI gene database focuses on acquired antibiotic resistance. In building it, NCBI aggregated collections of gene sequences from multiple sources<sup>1</sup>, resolved conflicting data, and supplemented the content with additional sequences found through the review of published scientific literature. This year's initial release delivered information on more than 3,000 acquired resistance genes and proteins and 33 drug classes.

The combination of these data—bacterial genome sequences annotated with genes known to confer resistance to antibiotics, together with laboratory results about the sensitivity of the bacteria to different antibiotics—provides valuable information for scientists as they address the problem of antibiotic resistance.

Using tools such as NCBI's Basic Alignment Search Tool (BLAST), scientists can rapidly compare bacterial sequences they have identified to sequences in the database to find similar genomes. Such similarities can provide clues to the antibiotic resistance they might see with the original bacteria. For example, NCBI scientists used the system to detect the fourth US isolate that encodes MCR-1, a resistance gene for colistin, a drug of last resort for many multi-drug resistant organisms.

Researchers also use the database for surveillance, for instance, to track bacteria found in food or the environment that is similar to bacteria that have shown antimicrobial resistance.

The antimicrobial resistance project builds on NCBI's Foodborne Pathogens Project, which has helped track foodborne disease outbreaks of *Listeria*, *Salmonella*, and *E. coli* since 2013. This project uses whole-genome sequencing to track foodborne diseases, an approach that quickly and accurately determines if two isolates of bacteria are from the same outbreak by looking for similarities in bacterial DNA.

The pipeline begins with partner labs at CDC, FDA, and USDA sequencing samples from human patients, food, and the environment. These agencies send the raw sequencing data to NCBI, which assembles the sequences and compares them to the sequences of other isolates in its database to identify those closely related.

As with humans, the genetic code (or genome) for each foodborne pathogen is unique, and the genomes from pathogens involved in the same outbreak

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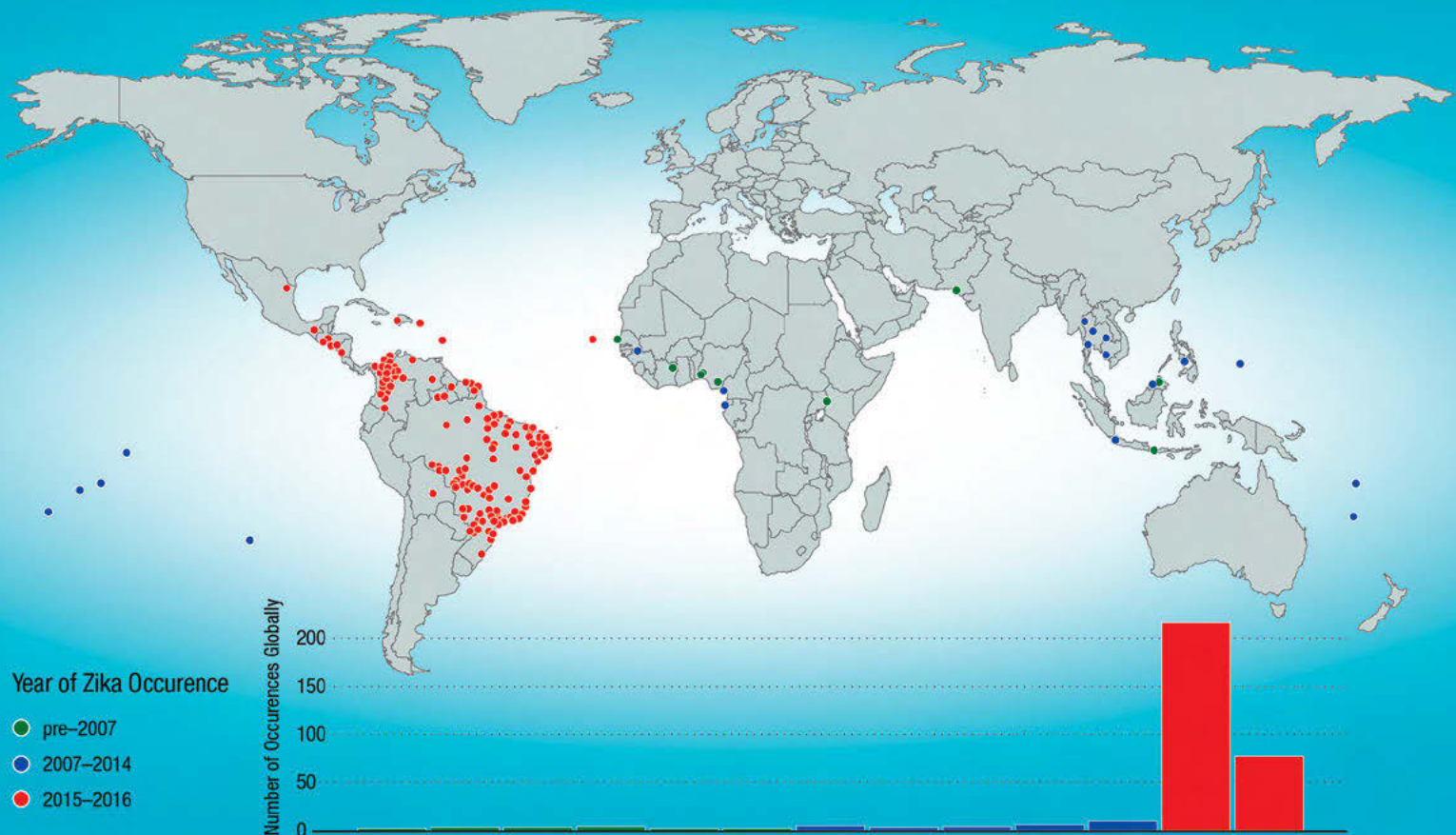
1. Major contributors to NCBI's database of antimicrobial resistance genes include: Resfinder, the Center for Veterinary Medicine at the Food and Drug Administration, the Comprehensive Antimicrobial Resistance Database, the Institut Pasteur, Dr. George Jacoby, Dr. Karen Bush, Dr. Timothy Palzkill, Dr. Marilyn Roberts, and Dr. Derrick Crook.

are typically very similar. These similarities allow scientists and public health officials to link cases of foodborne illness, even if they occur in separate locations—or to know they're not related at all. Furthermore, given the sensitivity and specificity of whole-genome sequencing, scientists can also tell which ingredient in a multi-ingredient food is responsible for an outbreak and help pinpoint its geographic source.

As a result, public health agencies can more quickly determine the cause of an outbreak and take action to minimize further cases of the disease and the number of people getting sick.

Together these NCBI initiatives increase the government's ability to monitor and track antibiotic resistant bacteria and to respond to foodborne disease outbreaks, making the world a healthier and safer place.





## Monitoring Trends, Tracking Zika

At the height of the Zika outbreak, public health officials were scrambling to determine where the disease was likely to spread. NLM grant recipient Dr. John Brownstein dived into the question as well but with an unorthodox approach—mining search engines, social media, and other nontraditional digital sources to spot outbreaks and detect trends.

Brownstein applied these widely-used online tools to project Zika’s spread in Colombia with results comparable to traditional disease surveillance data. He described his methodology and results in the article “Utilizing Nontraditional Data Sources for Near Real-Time Estimation of Transmission Dynamics During the 2015-2016 Colombian Zika Virus Disease Outbreak,” published this year in *JMIR Public Health and Surveillance*.

“We are now at a point where we can combine information streams from diverse sources—electronic medical records, social media, environmental data—to build risk projections,” Brownstein said.

Brownstein is coupling his disease surveillance efforts with research into the efficacy of disease control strategies, including vaccination, quarantine, and travel restrictions. “When you employ mathematical modeling, you can look at what various mitigation strategies might be able to stop an epidemic, or

use transport data and the risk of movement to project where a virus could spread,” he explained.

Though Brownstein’s work this year focused on the Zika virus, his research in public health informatics has involved a panoply of infectious diseases, including dengue, HIV, influenza, listeria, Lyme disease, malaria, respiratory syncytial virus, salmonella, and West Nile virus. He and his team also developed HealthMap, which uses informal and disparate online sources to monitor in real-time disease outbreaks and emerging public health threats. In 2010, Brownstein was awarded a Presidential Early Career Award for Scientists and Engineers for his efforts to develop a platform for modeling the global impact of climate change on infectious diseases. NLM funded this research through grant R01LM10812.

Now, as chief innovation officer at Boston Children’s Hospital and professor at Harvard Medical School, Brownstein has introduced visionary methods for public health surveillance and for statistically modeling that surveillance data.

“We make everyone a stakeholder when it comes to data about outbreaks, including consumers,” says Brownstein. “We’re thinking about how to communicate and empower everyday people to really understand what the risks are, what the true information is about a disease event, and what they can do to protect themselves and their families. It’s all about trying to demystify outbreaks.”

## NLM Zika Virus Response

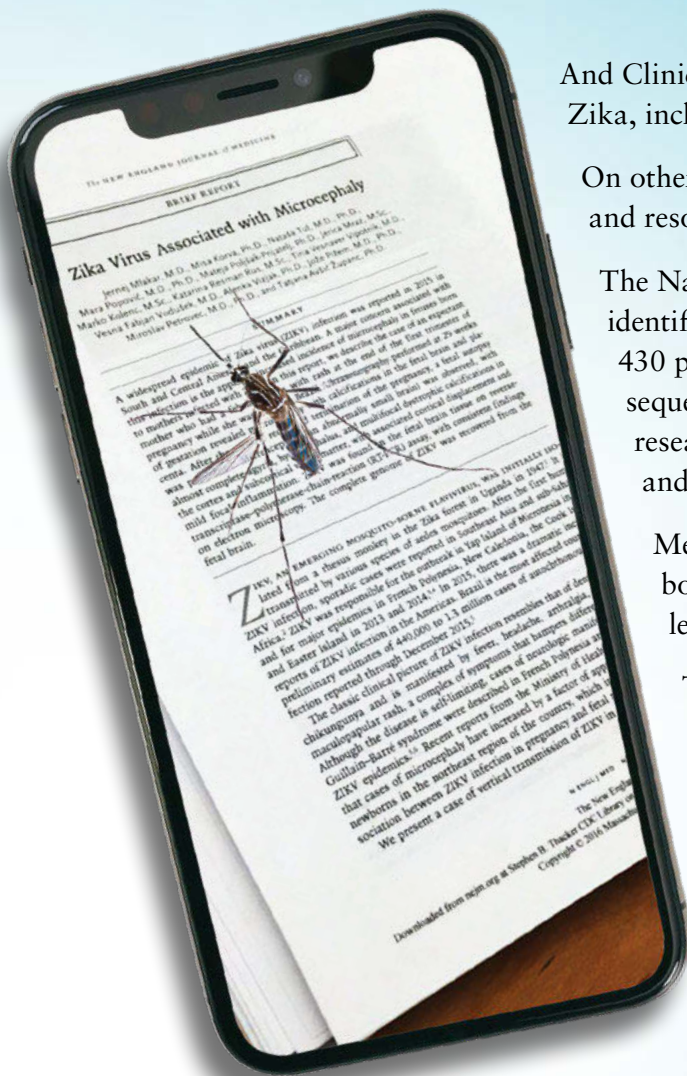
Near the start of the Zika outbreak, CDC Director Dr. Tom Frieden tweeted a photo of a small stack of journal articles with the caption “Entire world literature on Zika. 50 years of neglect.”

That would change quickly.

With the outbreak catalyzing research and sparking a global response, PubMed added more than 1,000 references on Zika this year, with over 600 full-text articles available for free.

NLM’s Disaster Lit database rapidly increased its collection on the topic, adding about 300 reports, guidelines, hearing transcripts, assessment tools, and webinars from various government agencies, international and non-governmental organizations, and academic institutions.

The NLM Disaster Information Management Research Center (DIMRC) identified several open data sets from the University of Wisconsin, the University of Washington, and the World Health Organization, among others.



And ClinicalTrials.gov added about a dozen studies on Zika, including several vaccine trials.

On other fronts, the Library responded with new tools and resources for a range of audiences.

The National Center for Biotechnology Information identified, collected, and made available more than 430 publicly shared genomic, nucleotide, and protein sequences associated with the Zika virus to help researchers better understand its molecular basis and transmission.

MedlinePlus added a health topic page on Zika for both the English- and Spanish-speaking public to learn about symptoms, treatment, and prevention.

The Library's History of Medicine Division activated its web archiving initiative, collecting and preserving selected born-digital resources to document the response to the virus for the sake of future researchers.

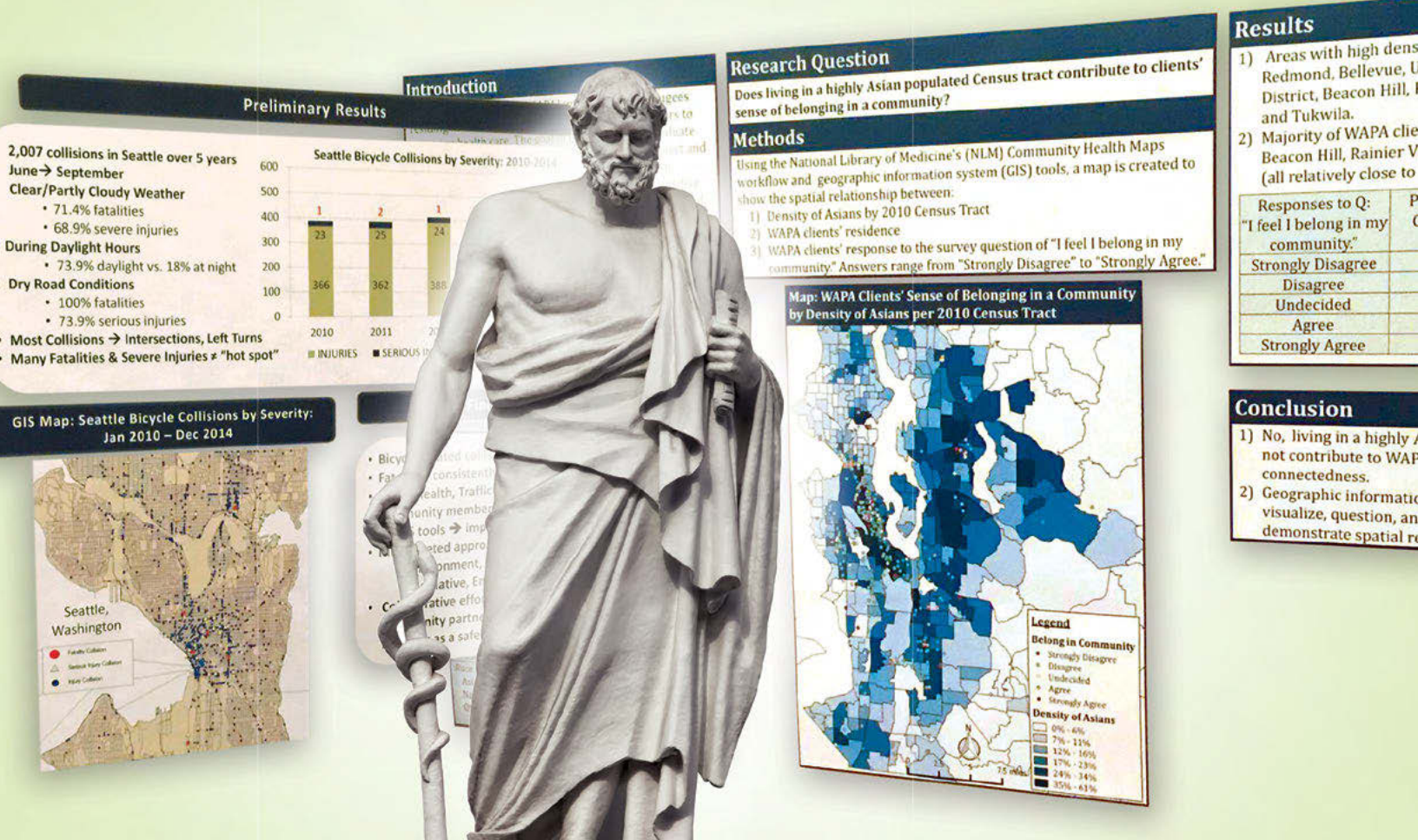
And NLM Terminology Services staff worked with the CDC to expand the standardized terminology and codes to support electronic health records, including lab reporting, clinical observations, congenital anomalies, clinical decisions, and diagnoses. MeSH, SNOMED CT

US Edition, RxNorm, and LOINC were enhanced accordingly.

DIMRC pulled all these and other resources together into a Zika Virus Health Information Resource Guide. This guide provided access to the full array of NLM resources on Zika—research literature, clinical trials, consumer information, relevant vocabularies, and genetic sequences—along with content from a variety of other US federal and international agencies and organizations. The guide also pointed to surveillance and vector control initiatives, social media sites, and maps to help monitor the rapidly emerging information on the disease.

DIMRC's situational awareness regarding the Zika virus and other such outbreaks or emergencies, along with specialized contributions from all corners of the library, helps ensure that NLM remains a relevant and timely source for trustworthy health information, whether for a concerned public, challenged health care providers, or scientific researchers looking to make a difference.





# Mapping Health

Hippocrates and digital mapping systems.

Not a pairing most would instinctively make.

But the father of modern medicine proposed as early as the 5th century BCE that location impacted health. That idea has been tested and applied to a range of issues from cholera in 19th century London to Zika today.

In the last few decades, the practice has gotten turbo-charged thanks to geographic information systems (GIS), which more readily allow researchers to plot and track the spatial distribution of diseases or conditions and apply modeling to predict changes over time. NLM has helped researchers and librarians apply GIS to health-related issues, and public health and medical geography are reaping the benefits.

## Community Health Maps

NLM's Community Health Maps (CHM) blog provides information on low- and no-cost tools for mapping public health issues and visualizing the impact of location on health conditions or outcomes. It targets those

intrigued by the potential uses of mapping in public health but who need understandable help and advice to get started.

CHM blog posts explain the technology, highlight inexpensive tools and software, and share real-life examples. NLM staff then present the CHM workflow in workshops that deliver practical advice for collecting, analyzing, and presenting key public health data tied to local issues.

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### Mapping Tools for Outreach and Public Health Workshop

NLM held one such workshop in June 2016 to demonstrate community mapping tools. Sixty participants heard from a GIS expert, educators, and students about projects that effectively used visualization and mapping tools in outreach and education. Participants then used those tools to gather their own data. Instructors guided them through the steps to turn their data into maps or visual representations, demonstrating the power of mapping to highlight patterns and tell stories not readily visible in the raw data.

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### Demonstration Projects

To further demonstrate the power of mapping health, NLM funded three projects that used data to visualize community issues or tell a story.

- **Bicycle Injuries and Fatalities:** A University of Washington graduate student worked with the violence and injury prevention unit of Seattle and King County's public health department to identify geographic clusters where bicycle injuries and fatalities occurred.
- **Wellness for Asian Pacific Americans Project:** A University of Washington graduate student partnered with International Community Health Services and the Asian Counseling and Referral Service at the University of Washington to assess whether a relationship existed between where patients lived and their mental health treatment outcomes.
- **Mapping Prevention of Zika Virus:** The Medical University of South Carolina developed a curriculum to help educators teach students about the Zika virus, including how to collect risk-factor data in the community and translate that data into customized maps.

Whether blogging, delivering workshops, or funding demonstration projects, NLM's work with health mapping and visualization helps librarians and their communities consider how they might collect, analyze, and present public health data to address local issues and make changes for the better.



## Images & Texts in Medical History

Innovation and data science aren't just about the future. They can also inform how we understand the past.

On April 11-13, 2016, seventy-five participants and observers participated in a workshop at NIH to learn how to better use the growing body of medical-historical digital images and texts and the qualitative and quantitative data related to them.

The workshop, *Images and Texts in Medical History: An Introduction to Methods, Tools, and Data from the Digital Humanities*, was the first of its kind at NIH. It arose out of NLM's ongoing partnership with the National Endowment for the Humanities to develop initiatives that bring together specialists from the humanities, medicine, and information sciences to share expertise and develop new research agendas.

Leading scholars in the digital humanities demonstrated and discussed how emerging approaches for analyzing texts and images can inform our understanding of the spread of disease, the rise of health professions, scientific research, health policy, and cultural definitions of health and disease. Faculty, scholars, librarians, archivists, and advanced graduate students attended.

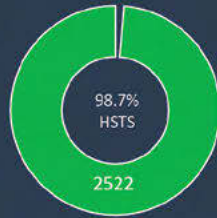


Digital humanists, Miriam Posner, PhD, from the University of California Los Angeles, and Ben Schmidt, PhD, from Northeastern University, provided hands-on instruction in analysis tools and methods. Posner focused on image-detection software, and Schmidt shared tools for term clustering and text mining. Medical historian Jeremy A. Greene, MD, PhD, from Johns Hopkins University, delivered the keynote, “The Analog Patient: Imagining Medicine at a Distance in the Television Era,” exploring how the evolution of telemedicine might guide us through today’s electronic and mobile health revolution.

The workshop also included a presentation about the Medical Heritage Library, a digital curation collaborative among some of the world’s leading medical libraries. (NLM is a founding member.) The day concluded with 17 three-minute lightning talks by workshop participants, during which they summarized their digital projects. These ranged from a study of advertisements depicting the use of antibacterial hexachlorophene (presented by Martha Gardner, Massachusetts College of Pharmacy and Health Sciences) to documenting and analyzing the production and use of rayon (presented by Jongmin Lee, University of Virginia) to Dutch public discourse on morphine (presented by Lisanne Walma, Utrecht University).

Hosted by NLM’s History of Medicine Division, the workshop was funded by the National Endowment for the Humanities through a grant to Virginia Tech, with support from The Wellcome Library and The Wellcome Trust. The workshop followed on NLM’s cooperative involvement in the April 2013 symposium *Shared Horizons: Data, Biomedicine, and the Digital Humanities*, held at the University of Maryland-College Park, and the October 2013 symposium *An Epidemiology of Information: New Methods for Interpreting Disease and Data*, held at the Virginia Tech Research Center in Arlington, Virginia.

HTTPS Status



NIH HTTPS Compliance

Legend



SSL Labs Grade



■ N/A ■ Mixed ■ T ■ M ■ F ■ C  
■ G ■ A

Legend Zoom in



Legend Zoom in



Summary

Show 10 entries

[Export to CSV](#)

[Show Organization overview](#) [See what has changed](#) [Add domains request](#) [Remove domains request](#)

Filtered by Status: ~~HSTS (X)~~

Filtered by Grade: ~~A (X)~~

Search

# NLM Dashboard Charts Security Improvements

When it comes to IT security, no one can go it alone. This year NLM’s Office of Computer and Communications Systems (OCCS) proved the truth of that adage through the HTTPS Dashboard OCCS staff developed and shared with other NIH units.

Created in response to a policy memo issued by the Office of Management and Budget, the HTTPS Dashboard captured the state of HTTPS implementation across all NLM and NIH websites and web services. That memo, “Policy to Require Secure Connections across Federal Websites and Web Services” (M-15-13), requires all publicly accessible Federal websites and web services to use only secure connections (HTTPS) by December 31, 2016. HTTPS (Hypertext Transfer Protocol Secure) protects user privacy by encrypting the data being sent back and forth between the user and the web server.

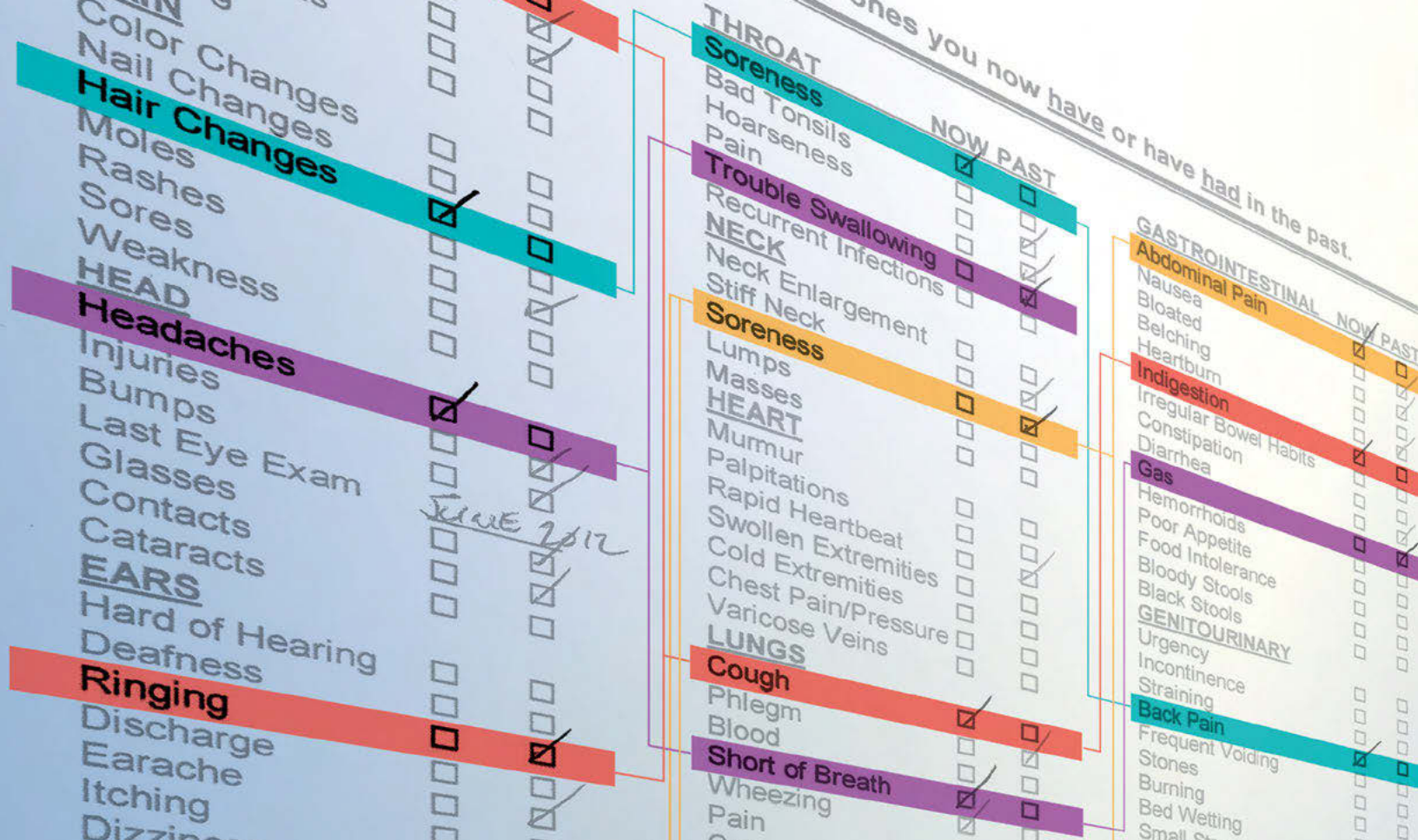
With a firm time constraint and hundreds of public-facing websites and web services to convert, NLM, along with the rest of NIH, faced a substantial technical and administrative challenge. While looking for the best method to track its own efforts to comply with the memorandum, NLM OCCS crafted

a solution that addressed those challenges for both itself and the other 26 institutes and centers (IC) across NIH.

NLM engineers found they could track automatically and in real-time the HTTPS status of each individual web host by repurposing pieces of the underlying scanning and verification APIs that GSA had used for its high-level US Government HTTPS dashboard.

Leveraging these automated status updates and incorporating feedback from NIH security personnel, the team designed and implemented the NIH HTTPS Dashboard that gave technicians and managers the ability to see and understand their IC's compliance data at the speed of thought. The dashboard allowed them to quickly assess not only how far they had come in meeting the HTTPS directive, but also exactly where they were falling short and what needed to be done to resolve those issues.

Since its launch, the NIH HTTPS Dashboard has been the centerpiece of the NIH effort to migrate over 2,550 unique internet hostnames from HTTP to HTTPS, serving as both a map to direct efforts and a reporting tool to track progress. NLM attained 49.5% compliance and NIH reporting offices 26.9% compliance by the end of the fiscal year, but with the conversion process well-established and the dashboard delivering up-to-the moment status reports, full or near-full compliance is expected by the year-end deadline.



# MetaMapLite: Recognizing Text...Faster

For more than 20 years, NLM has been studying and developing methods to automatically index the medical literature and to find specific concepts in text, such as disease names or clinical findings. Central to this effort has been MetaMap, a program that evolved over years to have sophisticated natural language capabilities. The specifics of that evolution, however, left MetaMap trailing its peers in simplicity, speed, and features.

To bring it up to speed, the Lister Hill National Center for Biomedical Communications introduced MetaMapLite, a new open source version of MetaMap. Written in JAVA—a language with a broad programmer following and immense industry support—MetaMapLite is an order of magnitude faster than its progenitor and other open source alternatives, and far easier for programmers to remodel and repurpose.

As with MetaMap, MetaMapLite can use NLM's MeSH vocabulary, the Unified Medical Language System (UMLS), or any site-specific vocabulary to precisely identify concepts in text. When combined with the Custom Taxonomy Builder, MetaMapLite generates editable UMLS subsets from

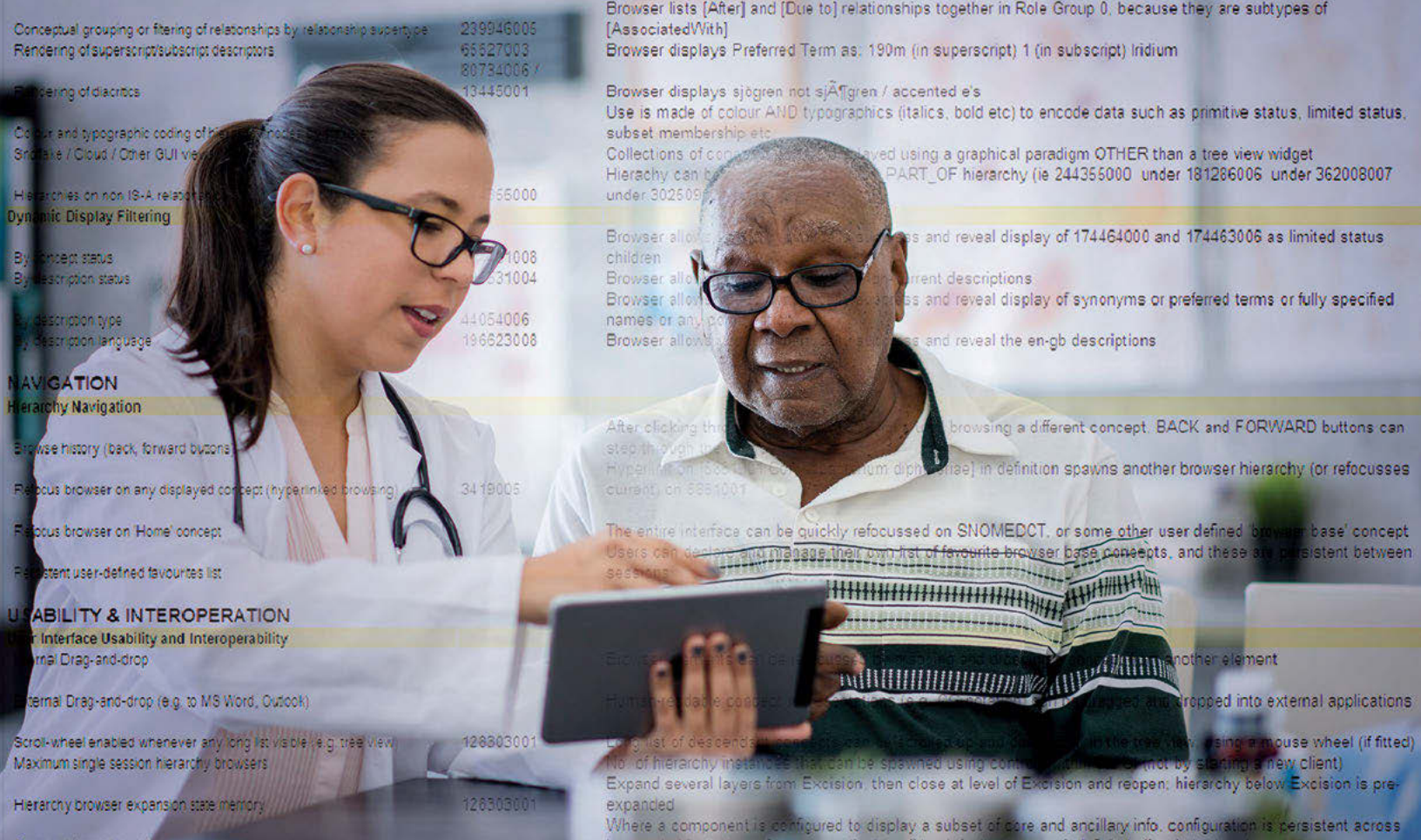
a list of seed terms, e.g., a clinical phenotype. The resulting subsets save time and effort by focusing results on only those concepts of interest.

MetaMapLite also handles more diverse types of text than its predecessor, including clinical texts such as progress notes, discharge summaries, radiology reports, and more. It can distinguish negative from positive statements about a disease or finding, a capability of special importance to clinical text interpretation, where negatives are common in patient histories, e.g., “No family history of cancer, heart, liver, or kidney disease.” And it can identify physical findings and symptoms in raw text, such as the narrative in electronic health records, an advance that can dramatically improve clinical care, decision support, and research.

The speedier and more sophisticated MetaMapLite has a range of uses. Researchers at the University of Texas applied it to electronic health records to more efficiently match patients to clinical trials. NLM used it on behalf of the FDA to catalogue adverse reactions associated with specific drugs. And MetaMapLite underpins a system called InfoBot at the NIH Clinical Center, where it helps develop evidence-based care plans for interdisciplinary teams.

As more uses emerge and users submit feedback, NLM staff will continue to develop the tool’s abilities with the goal of bringing natural language processing to more diverse library, research, and clinical applications.





# Collaboratively Creating Value Sets

The Value Set Authority Center (VSAC) launched in December 2015 the VSAC Collaboration Tool as a separate, yet integrated, workspace where value set authors can propose value sets for group discussion and development.

The VSAC Collaboration Tool offers authors, stewards, and invited collaborators a central site where they can monitor and discuss value sets as they develop. The tool can notify team members when their value sets are changed or when expansions are ready for review. Teams can arrange value sets to match their usage patterns or workflow needs, and members may assign keywords to value sets to help with organization and recall.

To start the process, users can pull content—whether one value set or many, such as all the value sets that comprise a clinical quality measure—from VSAC into the Collaboration Tool, where it is then available for discussion. For example, a value set author, working in VSAC, can draft a new value set or propose revisions to an existing value set. In doing so, she can draw terms from across various standard vocabularies, such as SNOMED CT, ICD-9, ICD-10, LOINC, and RxNorm. The author can then post that draft content to the integrated VSAC Collaboration Tool, where invited collaborators can discuss it, suggest additions or changes both within and across the various



terminologies, comment on others' suggestions, and review the evolution of the proposed set from introduction to acceptance.

Given the consensus building it enables, the VSAC Collaboration Tool has the potential to improve the quality of value sets created—and by extension, the effectiveness of the clinical quality measures they support—but that is not the only way the tool saves time and improves outcomes.

Authors can also use the connections and data that underpin VSAC to validate their value sets against the full array of health care vocabularies. With 148 versions, past and present, of 39 different terminologies included, VSAC can automatically mark deprecated codes. Authors can even specify the version of each terminology the tool should use to validate their value sets.

In addition, when authors post their value sets to the VSAC Collaboration Tool, the tool generates value set quality assurance reports, saving time for value set authors and ensuring currency and accuracy within value sets.

NLM developed the VSAC Collaboration Tool in cooperation with the HHS Centers for Medicare and Medicaid Services (CMS) and the HHS Office of the National Coordinator for Health Information Technology.

At the end of FY2016, VSAC included 2,670 value sets, most created by CMS. Access to VSAC and the VSAC Collaboration Tool is free but requires a Unified Medical Language System Metathesaurus License.

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## **NLM's Part in Clinical Quality Measures**

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HHS is working to improve the health of our nation by transforming care from a volume-based, provider-centered system to a patient-centered, learning health system. NLM contributes to this effort by creating and maintaining standard terminologies used in various health care systems, such as electronic health records, pharmacies, and hospital information, and to build value sets that, in turn, define the elements included in clinical quality measures. NLM also maintains the Value Set Authority Center (VSAC), the central repository for the official versions of value sets used in electronic Clinical Quality Measures (eCQMs) and other programs and applications.

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### **terminology**

A standardized collection of concepts with each concept represented by a unique code and a human readable description.

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### **value set**

A subset of concepts drawn from one or more terminologies, where the concepts included in the subset share a common scope.

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### **clinical quality measure**

A tool that combines logical statements and value sets to measure and track the quality of health care services.

## Search Learning Resources Database

Subject Area Revised From Revised To 

Search

Reset

## Online tutorials, videos, and other instructional materials

Use the search bar above to find resources by keyword, subject or date. See all resources by searching \*.

Radiation  
Emergency Medical  
ManagementGenetics  
Home  
Reference

ClinicalTrials.gov

*Images from  
the History of Medicine*Health  
ReachHealth Literacy  
Tool Shed

## New & Improved Online

NLM developed the Learning Resources Database to pull together in one location educational handouts, tutorials, and videos on many NLM products and services, including PubMed, PMC, ClinicalTrials.gov, DOCLINE, MeSH, and ToxNet.

Developed by NLM staff, these educational resources reflect skills and expertise from across disciplines—library science, bioinformatics, medicine, environmental science, software development, and more—and collectively offer hundreds of tips and tricks to improve search skills or expand understanding of topics ranging from bioinformatics and disaster management to genomics and toxicology.

Previously spread across the NLM website or tucked into hard-to-find digital corners, these diverse educational materials are now easy to locate by searching the Learning Resources Database by keyword or limiting results by subject, product, or last revision date. Users can also control whether or not to retrieve archived materials. And for those wanting to bring these resources to their own audiences, a companion API allows for sharing NLM learning resources on their websites.

The Learning Resources Database includes about 300 tutorials and handouts. Additional resources are added as they become available.

## HealthReach

[healthreach.nlm.nih.gov](http://healthreach.nlm.nih.gov)

### Purpose

The site delivers multilingual, multicultural health information such as brochures, fact sheets, handouts, audio recordings, and videos—for those working with or providing care to individuals with limited English proficiency. It contains provider tools such as reports, toolkits, and research briefs on best practices and cultural information.

### New features

It's a completely new look and a new name for the site formerly known as the Refugee Health Information Network. In addition to the search and browse functions, some resources are pre-sorted into helpful categories like women's health, family planning, and weather emergencies.

### Background

Many resources come from hospitals, health centers, government agencies, universities, and non-profit health groups. Those that have been medically reviewed are clearly marked.

## Health Literacy Tool Shed

[healthliteracy.bu.edu](http://healthliteracy.bu.edu)

### Purpose

This site helps researchers learn about health literacy measurement tools and identify specific tools that meet their research or practice needs.

### New features

The new site launched in November 2015 with more than 100 curated and empirically validated health literacy instruments. Filters, such as domain measured, context, administration time, sample size, and language, help narrow search results.

### Background

NLM developed the site in collaboration with the Boston University School of Medicine. Each instrument in the database is peer reviewed by health literacy research experts.

## Genetics Home Reference

[ghr.nlm.nih.gov](http://ghr.nlm.nih.gov)

### Purpose

The site provides information for consumers about genetics, from how genes work to how mutations cause disorders. It addresses genetic conditions and the gene and chromosome mutations related to those conditions.

### New features

A major overhaul of the website's look and feel improved the layout, organization, navigation, colors, and fonts. The homepage now includes a dynamic list of new and updated content, and the number of images across the site has multiplied significantly in response to user requests.

### Background

The site includes user-friendly summaries of more than 1,100 genetic conditions, more than 1,300 genes, all the human chromosomes, and mitochondrial DNA. Experts in human genetics review all topics, which are regularly added and updated.

**Images from the History of Medicine**[collections.nlm.nih.gov](http://collections.nlm.nih.gov)**Purpose**

This wide variety of visual media—including art, photographs, engravings, and posters—illustrates the social and historical aspects of medicine from the 15th to the 21st century.

**New features**

Nearly 68,000 images from the NLM History of Medicine Division were integrated into the NLM Digital Collections database, making it easier to search all digitized historical content at once. Those wanting to search only images can refine their results by the “Collections” facet.

**Background**

The International Image Interoperability Framework made it possible and more attractive to merge Images from the History of Medicine with the NLM Digital Collections. This revolutionary approach makes it easier and faster to serve up digital images while offering new capabilities for viewing, using, and interacting with those images online.

**Radiation Emergency Medical Management (REMM)**[remm.nlm.gov](http://remm.nlm.gov)**Purpose**

REMM delivers interactive clinical tools and data to help health care personnel diagnose and treat radiation injuries.

**New features**

Aside from a complete facelift, the site updated the Protective Action Guides and added new reference materials, countermeasures, and standards of care. To ease use during emergencies when the internet might not be accessible, REMM can be downloaded for use offline or accessed via a self-contained mobile app.

**Background**

NLM developed the site in collaboration with the HHS Office of the Assistant Secretary for Preparedness and Response and with contributions from HHS subject matter experts and other US and international consultants.





# Reunification through PEOPLE LOCATOR

## Finding a life, saving a life

A Pakistani man is alive because of the quick thinking of NLM experts and their use of PEOPLE LOCATOR®, part of NLM's Lost Person Finder Project.

The drama began with a fortuitous discovery during a routine data check. An NLM software developer spotted a cry for help among the missing person entries the Library had received from Google Person Finder following a magnitude 7.5 earthquake in South Asia in October 2015.

The translated message read, "I am stuck under the roof. Can someone please take me out?"

Within hours, staff at the Lister Hill National Center for Biomedical Communications got word of the man's plight to the Pakistani Disaster Management Agency, who then sent a rescue team to the location. The man was found alive, though NLM could get no further details regarding his condition or the rescue.

More than 400 people were killed and 2,500 injured in the earthquake.



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### Reuniting families

Six months later, another devastating earthquake struck, this time in Ecuador.

The country's Ministry of the Interior reached out to NLM requesting deployment of PEOPLE LOCATOR, and the Ecuadorian government used local media to urge citizens to enter the names and details of missing persons into the system. More than 3,000 entries flooded in, about a third with photos.

Though the Ministry has provided no details regarding outcomes, it was the first time a country requested deployment of the system.

In both instances, as well as in the 12 other times the Library activated PEOPLE LOCATOR this fiscal year, the system performed as intended: facilitating family reunification, enhancing coordination with non-governmental organizations, and alleviating some of the workload on emergency responders and public health personnel.

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### Working together

To maximize access to missing person listings, PEOPLE LOCATOR shares its information with Google Person Finder (and vice versa). Together the systems serve as an online "lost and found" of people, with entries that can include name, gender, age, health condition, and photo.

The free ReUnite® app, also part of the Lost Person Finder Project, allows users to input information to or search PEOPLE LOCATOR via mobile devices.

Additionally, TriageTrak®, a version of PEOPLE LOCATOR specifically for hospitals, relies on photos, rather than text, to identify and locate victims.

The Lister Hill Center started the Lost Person Finder Project nearly a decade ago to help reunite families after disasters. The center activates PEOPLE LOCATOR in response to large-scale emergencies, including floods, earthquakes, and typhoons



## Outreach to Native Peoples

### The Hokule'a and Native Hawaiian Health

The Hawaiian double-hulled voyaging canoe Hokule'a stopped in the Washington, DC, area in May 2016 as part of its worldwide voyage of peace, health, and ecological preservation. That 60,000-nautical-mile journey included visits to 100 ports in 27 countries.

Due to the central role of the Hokule'a in the NLM *Native Voices* exhibition, the Library coordinated the canoe's visit to the national capital region. The visit included a special lecture by Nainoa Thompson, Hokule'a senior navigator and president of the Polynesian Voyaging Society. Speaking to a standing-room-only crowd, Thompson connected the rebirth of the Native Hawaiian voyaging canoe to a cultural renaissance and with it, to a revitalization of Native Hawaiian health and pride—ideas that remain at the heart of the Hokule'a's global voyage.

In conjunction with the visit, NLM launched a Hokule'a microsite that pulled into one place all the Hokule'a-related material from the *Native Voices* exhibition.

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### *Native Voices: Native Peoples' Concepts of Health and Illness* Traveling Exhibition

The *Native Voices: Native Peoples' Concepts of Health and Illness* traveling exhibition completed the first year of its four-year tour that will eventually take it to 104 sites across the United States, including about 20 Native American venues. The exhibition examines how wellness and illness are interconnected with cultural life within Native communities.

Using interactive iPads and six informative banners, the traveling exhibition addresses the themes of individual, community, nature, tradition, and healing among Native Peoples. The iPads provide hundreds of video interview segments with American Indian, Alaska Native, and Native Hawaiian health practitioners and leaders; photos of Native healing and ceremonial objects and practices; and a timeline of key events and milestones in the history of Native Peoples and their health and healing activities.

The exhibition visited 19 locations in FY2016, including Native communities or tribal colleges in Kansas, Minnesota, Montana, and Oklahoma. Venues hosting *Native Voices* often worked with nearby tribal groups or other partners to expand upon the exhibition's themes via public programs or local artifacts.



*National Library of Medicine/Bryant Pegram*

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### American Indian Mid-Atlantic Powwow Outreach Program

FY2016 marked the fifteenth year of NLM's outreach program to American Indian powwows. NLM staff participated in a dozen events across Delaware, Maryland, New Jersey, North Carolina, Pennsylvania, and Virginia, offering attendees health information and instruction on NLM resources. As major social and cultural events for many American Indian tribes, these powwows drew several hundred to several thousand people, both from area tribal communities and the broader public. The modern form of the powwow emphasizes Native dancing, drumming, singing, food, and arts and crafts.

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### Chickasaw Health Information Center

Two new information kiosks providing access to the Chickasaw Health Information Center (CHIC) were installed at Chickasaw Nation health clinics in Ardmore and Tishomingo, Oklahoma,

this year. The new kiosks join the initial installation at the Chickasaw Nation Medical Center in Ada, Oklahoma, in providing convenient public access to quality consumer health information in a community where awareness of online options is low and bandwidth limited.

The CHIC helps patients learn how to improve their overall health and well-being through information from NLM and NIH. The kiosks help patients find answers to their health questions while waiting for medical appointments at the health clinics, while the companion CHIC website is available to those with internet access. NLM partnered with the Chickasaw Nation and a technology company owned by members of the Chickasaw Nation to develop CHIC.

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### Digital Storytelling Workshop

NLM financially supported a digital storytelling workshop at the American Indian Community House (AICH) in New York City in September. Building upon Native American oral tradition, the four-day workshop taught urban Native community members and AICH staff to visually and orally document their experiences of health and wellness. In contrast to an oral history, digital storytelling blends voice recording with photos, art, and music to capture personal stories in video. These health and wellness stories were shared with the community during a digital storytelling festival at AICH.

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### Women's Health Project

This year NLM funded an outreach project targeting women as the main information gatherer and health decision influencer in the family.

The Tribal Epidemiology Center, United and Southern Eastern Tribes, Inc. (USET), adapted *Partners for a Healthy Baby*, a Florida State University home visiting curriculum, to support traditional American Indian/Alaska Native parenting styles. The resulting *Indian Peer-to-Peer Family Curriculum* incorporated traditional parenting methods into Florida State's nationally recognized, research-based, practice-informed curriculum with the goal of improving pre- and post-natal care for Native mothers and strengthening the maternal role in the tribal community.

In crafting the curriculum, USET worked with NLM to develop training materials, online search strategies, and demonstrations of key library resources. Peer support groups use these training materials to teach mothers and other family members how to access health information.

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### Arctic Food Security

NLM funded an information outreach project at the University of Alaska, Anchorage. The project, *Food Justice in the Arctic: Community Action to Raise Awareness About and Mitigate Food Waste in Anchorage Households by Empowering Elementary School Children*, partnered university seniors with five elementary school classrooms to understand and map household food systems' sustainability. The students' work is expected to yield insights into food waste that can be used to reduce household and community food insecurity and injustice.

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### Environmental Health in Indian Country

Representatives from the 22 schools that comprise the Environmental Health Information Partnership (EnHIP) gathered for their annual meeting in March. Held this year at Haskell Indian Nations University in Lawrence, Kansas, they discussed *Environmental Health Disparities: Challenges and Opportunities*, looking in part at how environmental issues and their consequences are often disproportionately borne by people without resources and access, including tribal communities and other underserved populations.

As part of the meeting, faculty from Haskell Indian Nations University described recent environmental research projects that promote sustainable and restorative activities for Native communities and environmental health, often building upon Native people's cultural and spiritual connection to the environment. The meeting also included a presentation on the unique threat climate change poses to indigenous people's health, homes, and ways of life, and discussions about Native American culture and heritage.



# 2016 Divisional Reports



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# Office of Health Information Programs Development

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**Michael F. Huerta, PhD**

*NLM Coordinator of Data & Open Science Initiatives  
Associate Director for Program Development*

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The Office of Health Information Programs Development (OHIPD) is responsible for four major functions:

- establishing, planning, and implementing the NLM Long Range Plan and related program planning, analysis, and evaluation activities;
- coordinating, conducting, and supporting outreach and consumer health programs to improve access to NLM information services by all, including minority, rural, and other underserved populations;
- planning, conducting, and evaluating NLM’s international programs; and
- contributing to trans-NIH data science initiatives.

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## PLANNING AND ANALYSIS

NLM’s current long-range plan, *Charting a Course for the 21st Century: NLM’s Long Range Plan 2006–2016*, remains at the heart of NLM’s planning and budget activities. Activities for the next planning cycle, which began in FY2016, included identifying four major themes to help guide the upcoming strategic planning process and developing strategies to obtain community input.

OHIPD’s continued involvement in website

evaluation included:

- analyzing NLM website log data;
- continuing the trans-NLM web metrics program;
- coordinating the use of the online user survey known as the ForeSee Customer Satisfaction Index; and
- maintaining access to key audience measures gathered by a private sector company.

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## OUTREACH AND CONSUMER HEALTH

NLM carries out a diverse set of activities directed at building awareness and use of its products and services by health professionals and communities of interest. Considerable emphasis is placed on reducing health disparities by reaching rural and inner-city areas. An NLM-wide Coordinating Committee on Outreach, Consumer Health, and Health Disparities (OCHD) plans, develops, and

coordinates NLM outreach and consumer health activities. The OCHD is chaired and staffed by OHIPD.

In FY2016 OHIPD staff continued outreach initiatives intended to encourage underrepresented minority students to use NLM’s health information resources and to pursue careers in medicine and the health sciences.

OHIPD also participated in Native American outreach efforts to enhance awareness of NLM consumer-oriented resources among segments of the Native American community. As part of the NIH American Indian Pow-Wow Initiative, staff coordinated NLM exhibits at a dozen pow-wows in the Mid-Atlantic area. An estimated 3,800 persons visited the NLM booth over the course of these pow-wows.

OHIPD supported a project to build awareness of NLM health information resources, including the *Native Voices* exhibition, within segments of the Native American community in the Southwestern United States. Through the project, the University of New Mexico Health Sciences Library and Information Center (UNM HSLIC) reached out to eleven tribal libraries in New Mexico, plus one tribal

college in Arizona and one college in Colorado that serves tribal students. All libraries received NLM health information materials, including iPads pre-loaded with *Native Voices* content, and support from the UNM HSLIC.

In FY2016, the *Native Voices: Native Peoples' Concepts of Health and Illness* traveling exhibition visited 19 sites across the country, including several tribal colleges. The traveling exhibition conveys Native concepts of health and illness via six informative banners and interactive iPads loaded with over 200 video clips and images of Native artifacts and art. NLM partners with the American Library Association to manage the *Native Voices* traveling exhibition. See "Outreach to Native Peoples" (p. 27) for more information.

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## INTERNATIONAL PROGRAMS

International programs at NLM strengthen and expand global access to health literature and information, enhancing research and health care systems in low- and middle-income countries through outreach, education, capacity-building, and the development of information infrastructures.

This year's initiatives included the African Journal Partnership Project, the Tanzanian Health Information Specialist Training Program, Medical Informatics Training in Morocco, and outreach coordinated by the Network of African Medical Librarians.

Developed in 2003 in collaboration with the NIH Fogarty International Center, the African Journal Partnership Project pairs African medical journals with US and UK medical journals to help build the capacity to publish and maintain peer-reviewed medical journals and enhance scientific communication in sub-Saharan Africa. In FY2016 the project included nine African medical journals in nine countries.

In collaboration with the Tanzanian Ministry of Health and Social Welfare, OHIPD supported the

establishment of a Tanzanian Health Information Specialist Training Program, a three-year, diploma-level program to train medical information specialists. These health information specialists will be trained to provide evidence-based resources to clinicians; assist medical and nursing students; locate appropriate information for patients and families; help organize medical records; and facilitate the transition to electronic systems for records management. The ministry intends to place graduates in all government clinics, hospitals, and medical and nursing schools. FY2016 activities included finalizing the program and obtaining national accreditation for the curriculum and training sites.

NLM continued working with the Network of African Medical Librarians to help them build library and information access in Africa. The current network consists of seven librarians from Kenya, Mali, Mozambique, Nigeria, Uganda, Zambia, and Zimbabwe who received training as NLM Associate Fellows or as Medical Library Association Cunningham Fellows.

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## DATA SCIENCE

In FY2016, OHIPD contributed leadership and expertise to data science initiatives within NLM and across NIH, with programs designed to expand the capacity of the biomedical research enterprise to

organize, sustain, analyze, integrate, and generate new discoveries from the tidal waves of data emanating from research, health care, and social media. These data science initiatives aimed to raise



the prominence of data in the biomedical research enterprise, inform NIH policies and practice, and create long-term structural changes that will add value to the NIH research investment and accelerate the pace of progress.

OHIPD and other NLM staff members served on the Big Data to Knowledge (BD2K) Executive Committee and participated on five BD2K implementation groups. These trans-NIH groups helped facilitate data sharing, the use of data-related standards, and methods for making data discoverable, citable, and linked to the scientific literature; advanced understanding of the importance and content requirements of

data management and sharing plans; promoted use of clinical research data; developed funding opportunity announcements related to making biomedical research more data-centric and open; and organized national conferences on open/data science.

OHIPD also provided leadership to the trans-NIH Biomedical Informatics Committee, which facilitates and stimulates interaction across NIH institutes and centers. In addition, OHIPD staff chaired the Common Data Elements (CDE) working group, featuring coordination of some 20 CDE initiatives at NIH and expanding the suite of CDE resources.

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# Library Operations

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**Joyce E.B. Backus**

*Associate Director*

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The Division of Library Operations (LO) ensures access to the published record in biomedicine and related areas of the life sciences. LO acquires, organizes, and preserves NLM's comprehensive archival collection of biomedical literature; creates and disseminates controlled vocabularies and a library classification scheme; produces authoritative indexing and cataloging records; builds and distributes bibliographic, directory, and full-text databases; provides national backup document delivery, reference service, and research assistance; helps people make effective use of NLM products and services; and coordinates the National Network of Libraries of Medicine to equalize access to health information across the United States.

These essential services support NLM's outreach to health professionals, patients, families, and the public, and the development of focused programs in AIDS information, molecular biology, health services research, public health, toxicology, environmental health, and disaster preparedness.

Library Operations also develops and mounts historical exhibitions; produces and manages a travelling exhibition program; creates and promotes resources for K-12, undergraduate, and graduate

students and educators; carries out an active research program in the history of medicine and public health; collaborates with other NLM program areas to develop, enhance, and publicize NLM products and services; conducts research related to current operations; directs and supports training and recruiting programs for health sciences librarians; and manages the development and dissemination of national health data terminology standards.

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## COLLECTIONS

The NLM collection continues to shift from one dominated by print materials to an increasingly digital collection.

This year Library Operations initiated a Print-to-Electronic (P2E) project to migrate journals subscribed to in both print and electronic formats to electronic-only subscriptions. The project resulted in cancelling over 2,000 print subscriptions for 2017. These cancellations brought modest savings to the literature budget but potentially more significant savings in staff time because staff will no longer need to process print issues. All the subscriptions changed to electronic-only met the Library's

licensing criteria, including acceptable ILL terms, post-cancellation access, and preservation in either PubMed Central or Portico, a trusted, reliable digital preservation platform that serves the library and publisher communities. Additionally, the P2E project began developing procedures and tools for working with Portico to monitor the completeness of Portico's holdings.

NLM changed its journal selection process to now include evaluating the quality and suitability of journal publishers before reviewing their publications for inclusion in the NLM collection, including MEDLINE/PubMed and PubMed Central.

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## DATABASES

Library Operations and NCBI worked together to develop the new PubMed Data Management System (PMDM) to manage creating and maintaining MEDLINE/PubMed citations. Library Operations also partnered with OCCS to construct a complementary Indexing Management System (IMS) to facilitate indexing and assigning metadata for MEDLINE. Together these systems are expected to improve the speed with which the biomedical literature is made available to the public in MEDLINE/PubMed.

Library Operations transformed the data distribution program for MEDLINE and other files,

replacing the licensing requirement with a terms and conditions statement and instituting a more efficient process for distributing the data. As part of this transformation, staff redesigned the distribution program website to increase visibility of the data files and improve navigation.

Library Operations merged the Directory of History of Medicine Collections and the Guide to Oral History Collections into a single, user-friendly resource providing researchers with information about historical medical collections around the world.

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## TERMINOLOGY

Library Operations updated the MeSH RDF (Resource Description Framework) 2016 beta version. MeSH RDF, a linked data representation of NLM's Medical Subject Headings (MeSH), allows users to extract data from MeSH making use of the

hierarchy and connections between terms.

Library Operations also worked with OCCS to transition MeSH on Demand into a reliable production system people can use to identify MeSH terms associated with blocks of text.

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## OUTREACH AND PUBLIC SERVICES

MedlinePlus, the NLM consumer health website, obtained its own domain, medlineplus.gov, in July 2016. This clear, specific web address improved the site's findability via web search engines.

*Circulating Now*, the blog of the Library's History of Medicine Division, grew to over 330,000 followers, and published 82 posts in FY2016.

Six History of Medicine Lectures, each with an accompanying interview on *Circulating Now*, and three special programs highlighted the uniqueness and research value of NLM collections. Library Operations also established and announced the inaugural Michael E. DeBakey Fellowship in the History of Medicine, supported by a generous gift from the Michael E. DeBakey Medical Foundation.

Library Operations, in close cooperation with NCBI and OCCS, implemented a new Customer Service Software System to increase customer self-sufficiency with reliable information from

NLM's knowledge base. Users receive immediate responses, and fewer questions come to NLM staff.

The National Network Coordinating Office (NNCO), in concert with NLM's Extramural Programs, established cooperative agreements to operate the National Network of Libraries of Medicine (NNLM). The new 2016-2021 funding mechanism provides flexibilities and allows more involvement from NLM. The newly formed National Network Steering Committee guides and coordinates efforts across the Network through national initiatives and standards, and five national offices support Network-wide efforts: NNLM DOCLINE Coordination Office, NNLM Evaluation Office, NNLM Public Health Coordination Office, NNLM Training Office, and NNLM Web Services Office. (See Appendix 1 for the full list of Regional Medical Libraries and offices.)

## COLLECTIONS

TABLE 1: PHYSICAL COLLECTIONS

Item	Total <sup>1</sup>	FY2016	FY2015	FY2014
Monographs <sup>2</sup> : Before 1500	600	1	1	1
1501–1600	6,064	6	0	2
1601–1700	10,360	6	7	1
1701–1800	272,785	12	32	3
1801–1870	257,134	196	150	71
1871–present	909,979	11,052	12,893	13,560
Bound Serial Volumes <sup>3</sup>	1,538,146	23,127	34,723	15,806
Microforms <sup>4</sup>	606,239	99	14	42
Audiovisuals and Computer Software	99,292	1,577	2,359	2,395
Prints and Photographs	72,344	966	1,147	279
Manuscripts <sup>5</sup>	24,809,541	560,648	1,152,446	4,807,740
Withdrawn Items	-139,039	-356	-5,922	-549
<b>Total items</b>	<b>28,443,445</b>	<b>597,334</b>	<b>1,197,850</b>	<b>4,839,351</b>

- Total: Numbers are cumulative as of the end of the fiscal year.*
- Monographs: A bibliographic resource complete in one part or a finite number of separate parts. Includes Americana, theses, and pamphlets. Starting in FY2011 numbers for these materials are reported under monographs by publication year.*
- Bound Serial Volumes: A serial is a continuing resource issued in separate parts with no predetermined conclusion. Bound serial volumes include serials bound, serial pamphlets bound, and bound serial gifts.*
- Microforms: Reduced-size reproductions of monographs and serials including microfilm and microfiche.*
- Manuscripts: Total manuscripts equivalent to 16,513 linear feet of material, multiplied by a common factor to provide an item number estimate.*

TABLE 2: DIGITAL COLLECTIONS

Item	Total <sup>1</sup>	FY2016	FY2015	FY2014
PubMed Central Articles	4,028,799	405,233	396,187	368,111
PubMed Central Titles <sup>2</sup>	1,880	89	191	207
Bookshelf Titles <sup>3</sup>	4,805	730	969	1,387
Digital Collections Repository <sup>4</sup> : Texts <sup>5</sup>	16,732	1,633	2,898	2,642
Audiovisuals <sup>6</sup>	235	35	38	55

- Total: Numbers are cumulative as of the end of the fiscal year.*
- PubMed Central Titles: Only fully deposited titles.*
- Bookshelf Titles: Titles of books, reports, databases, documentation, and collections.*
- Digital Collections Repository: Digitized content in the public domain. In the future, it will contain born digital items as well as reformatted items.*
- Texts: Includes monographs and serials such as annual reports. Referred to as "Print Materials" on Digital Collections website.*
- Audiovisuals: Referred to as "Films and Videos" on Digital Collections website.*

## COLLECTION ACTIVITIES

TABLE 3: ACQUISITIONS AND PROCESSING

Item	FY2016	FY2015	FY2014
Active Serial Subscriptions	17,292	17,556	17,439
Items Processed <sup>1</sup> : Serial Pieces	91,846	75,193	94,738
Monographs (pre-1914) <sup>2</sup>	398	763	1,218
Monographs (1914- )	17,262	20,845	19,367
Audiovisuals <sup>3</sup>	753	481	241
Prints and Photographs	966	1,147	1,364
<b>Total</b>	<b>111,225</b>	<b>98,429</b>	<b>134,367</b>

1. Items Processed: Serial issues, monographs and nonprint receipts processed.
2. Monographs (pre-1914) includes historical manuscripts (those written prior to the year 1600).

3. Audiovisuals became a separate tracking category in FY2012. For prior year reports, Audiovisuals were grouped with Monographs (1914- ).

TABLE 4: ARCHIVAL MATERIALS ACQUIRED

Item	FY2016	FY2015	FY2014
Modern Manuscripts (in linear feet)	357	583	157

TABLE 5: EXPENDITURES

Item	FY2016	FY2015	FY2014
Publications	\$12,906,563	\$11,587,588	\$11,571,597
Rare Books, Manuscripts, and Other Historical Materials	\$299,568	\$300,214	\$299,841
<b>Total<sup>1</sup></b>	<b>\$13,206,131</b>	<b>\$11,887,802</b>	<b>\$11,871,438</b>

1. Used to be reported in "Publications" prior to FY2012, and "Rare Books" was a portion of the amount.

TABLE 6: PRESERVATION ACTIVITIES

Item	FY2016	FY2015	FY2014
Volumes Bound	21,628	33,028	14,516
Volumes Repaired Onsite <sup>1</sup>	499	684	685
Audiovisuals Preserved	532	731	811
Historical Volumes Conserved	614	713	583
Pages Digitized <sup>2</sup>	125,456	187,585	413,550

1. Volumes Repaired Onsite: General Collection monographs and serials only.

2. Pages Digitized: Number excludes digitization projects not associated with the Digital Collections Repository, e.g., Profiles in Science.



## CATALOGING AND INDEXING

TABLE 7: CATALOGING

Item	FY2016	FY2015	FY2014
General Collection Items <sup>1</sup>	20,248	17,935	18,755
Historical Monographs (pre-1914)	2,535	3,815	4,431
Modern Manuscripts (in linear feet) <sup>2</sup>	489	364	92
Prints and Photographs <sup>3</sup>	6,922	2,920	1,326
Historical Audiovisuals	1,572	227	875

1. *General Collection Items: Includes monographs, serials, nonprint, and integrating resources.*

2. *Number reflects manuscripts that are fully processed and have a catalog record.*

3. *Number includes accessioned prints and photographs that are described by finding aids.*

TABLE 8: INDEXING

Item	FY2016	FY2015	FY2014
Citations Indexed for MEDLINE	869,666	806,326	765,850
Journals Indexed for MEDLINE	5,623	5,618	5,647

## SERVICES TO THE PUBLIC

TABLE 9: DOCUMENT DELIVERY

Request Type	FY2016	FY2015	FY2014
Interlibrary Loan Requests Received	153,252	180,733	188,912
Interlibrary Loan Requests Filled	128,748	146,123	155,423
General Reading Room Requests Received	68,195	67,482	68,281
General Reading Room Requests Filled	62,068	61,602	61,713
History of Medicine Reading Room Requests Filled	10,369	7,996	8,660

TABLE 10: CUSTOMER SERVICE INQUIRIES

Inquiry Type	FY2016	FY2015	FY2014
Offsite Inquiries <sup>1</sup> : General	44,702	53,508	95,665
History of Medicine	4,357	6,234	5,776
Onsite Inquiries <sup>2</sup> : General	5,595	6,314	6,967
History of Medicine	7,314	8,133	9,750

1. *Offsite Inquiries: Inquiries via telephone, fax, US mail, and e-mail. Includes BSD interactions with data licensees. Beginning in FY2015, ILL requests are no longer included in the Customer Service Inquiry statistics.*

2. *Onsite Inquiries: In person.*

TABLE 11: DATA LICENSES

Platform	FY2016	FY2015	FY2014
MEDLINE	882	831	831
UMLS	20,861	10,095	12,627

TABLE 12: TOURS AND VISITORS

Outreach Activity	FY2016	FY2015	FY2014
Exhibitions: Visitors	99	1,571	2,700
Daily Tours: Tours	131	107	83
Visitors	873	552	508
Special Tours: Tours	64	75	75
Visitors	1,824	1,121	1,952

## WEB SERVICES

TABLE 13: SELECTED WEB RESOURCES

Resource	Statistic	FY2016	FY2015	FY2014
<b>ClinicalTrials.gov</b>	Number of Studies	228,385	199,725	176,622
	Page Views <sup>1</sup>	2,426,183,020	2,405,844,998	1,414,637,991
	Visitors <sup>2</sup>	14,233,210	13,731,543	11,264,641
<b>DailyMed</b>	Number of Labels	90,548	78,394	66,527
	Page Views	317,036,446	268,793,206	182,881,007
	Visitors	17,024,042	14,633,833	18,722,781
<b>Genetics Home Reference</b>	Summaries	2,505	2,515	2,376
	Page Views <sup>3</sup>	39,256,315	41,781,084	198,089,169
	Visitors	18,899,479	19,027,155	14,064,110
<b>Household Products Database</b>	Number of Products	16,000	15,000	14,000
	Page Views	31,655,224	26,669,097	41,757,342
	Visitors	861,993	900,468	970,643
<b>MEDLINE/PubMed</b>	PubMed Citations	26,482,097	25,375,421	24,289,399
	Page Views <sup>4</sup>	2,986,881,905	3,017,779,466	2,993,504,344
	Unique Visits <sup>5</sup>	799,497,585	752,310,089	741,750,623
	Searches <sup>6</sup>	3,133,664,852	2,796,260,949	2,650,894,898
<b>MedlinePlus</b>	Number of Topics (English/Spanish)	989/977	969/958	957/948
	Page Views <sup>7</sup>	928,200,000	932,300,000	1,023,100,000
	Visitors	416,100,000	404,500,000	409,800,000
<b>NLM Main Web Site</b>	Page Views <sup>7</sup>	21,000,000	19,300,000	60,300,000
	Visitors	8,200,000	5,300,000	14,500,000

(table continues)

Resource	Statistic	FY2016	FY2015	FY2014
<b>ToxTown</b>	Page Views	12,196,787	7,942,465	5,443,181
	Visitors	310,822	377,772	294,186

- Page Views: Number of times that a single page is viewed or downloaded.*
- Visitors: Number of people visiting a website in a defined period of time.*
- Genetics Home Reference changed web analytics reporting tools and, beginning in FY2015, reports Page Views rather than Page Hits.*
- The PubMed Page View totals for FY2015 and FY2014 have been corrected to reflect the change in analytics reporting tools.*
- Unique Visits: Total number of times that all users visit a website, regardless of the number of individual pages viewed.*
- Searches: Number of searches performed.*
- NLM changed web analytics reporting methodology and tools beginning in FY2015, resulting in more accurate numbers of Page Views.*

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# Specialized Information Services

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Gale Dutcher

*Acting Associate Director*

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The Division of Specialized Information Services (SIS) expanded in 1967 to include the Congressionally mandated Toxicology Information Program. Today SIS offers a wide-ranging collection of free and publicly accessible information resources and services in toxicology, environmental health, chemistry, HIV/AIDS, disaster medicine and public health emergencies, minority health, and other specialized topics.

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## DATABASES

The *AIDSinfo* Guidelines app, launched in December, provides mobile access to the federally approved HIV/AIDS medical practice guidelines. These clinical guidelines offer recommendations approved by expert panels for the treatment of adult, adolescent, pediatric, and perinatal HIV infection, as well as recommendations for the treatment of HIV-related opportunistic infections in adults, adolescents, and children. The app automatically refreshes content to ensure users have continual access to the most up-to-date guidelines.

*ChemIDplus* expanded to include content from several additional drug locators including DrugBank, a Canadian database on small molecule and biotech drugs. Other improvements, such as a combined autosuggest/spellchecker, make searching by chemical names easier and more accurate, while a new API streamlines access to and use of the data.

The Dietary Supplement Label Database, maintained in conjunction with the NIH Office of Dietary Supplements, now includes over 60,000 dietary supplement product labels—a milestone reached in September 2016. A new API allows developers to build applications and conduct data mining and bioinformatics research using the data.

The Environmental Health Student Portal launched four animations about plastics to help explain complex environmental health concepts to students and the public. The animations, each of

which spoofs a popular app or video game, cover such topics as how plastic is created, environmental health concerns, human health concerns, and recycling.

Based on a review of occupational journals, the occupational toxicology database Haz-Map changed the names for 20 main metals and added links to relevant PubMed abstracts.

The Household Products Database updated 16,000 records with new safety data sheets provided by the manufacturers. The database also now includes the product category “commercial/institutional” for products containing industrial strength ingredients.

The Hazardous Substance Data Bank (HSDB) now includes links from the records to related articles in PubMed. This feature allows users to access the most current toxicology literature while searching the database. In addition, HSDB added or updated records in support of the NIH Substances of Concern Reduction Initiative.

TOXMAP deployed the TRI 2014 National Analysis data simultaneously on both TOXMAP classic and beta in combination with TOXNET. TOXMAP also obtained hydraulic fracturing site and contaminant data from FracFocus and deployed a static map layer of fracking wells to the TOXMAP staging server. A full technology refresh included upgrades to the web server, the servlet engine, and

Java. The development of a working prototype for TOXMAP Lite set the stage for modernizing TOXMAP and enabling it to run on mobile devices.

The Wireless Information System for Emergency Responders (WISER) has been downloaded by over

1 million users. This year WISER fully integrated the DOT Emergency Response Guidebook, including the ability to map detailed distance data for certain chemicals, such as chlorine.

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## OUTREACH

The Environmental Information Partnership held its 26th annual meeting March 29-30, 2016, at the Haskell Indian Nations University, Lawrence, Kansas. Dr. Patricia Matthews-Juarez, the chair from Meharry Medical College, presided. The meeting theme was *Environmental Health Disparities: Challenges and Opportunities*.

SIS funded eight AIDS Community Information Outreach Projects in California, Illinois, Maryland, New York, Pennsylvania, Utah, and Virginia. The projects focus on improving information access for HIV/AIDS patients, their caregivers, and the affected community.

SIS and the National AHEC Organization (NAO) collaborated on a cross-country project designed to test a previously developed teen health information literacy model in various contexts such as urban settings and frontier regions. The project aimed to improve health knowledge, health information literacy, interest in health careers, community engagement, and leadership and communication skills of teens in disadvantaged communities. The six participating AHEC (Area Health Education Center) chapters implemented the Student Health Advocates Redefining Empowerment Project (Project SHARE) model curriculum originally

developed by the University of Maryland Health Sciences and Human Services Library with NLM funding. Students participated in a quantitative and qualitative evaluation to measure knowledge gained and interest in health careers.

SIS continued its partnership with the South Carolina AHEC on a teen health information literacy project. High school students researched public health themes and created educational comic books geared toward middle school students. In the process, the teens learned about helpful resources from the NLM, gained valuable communication, research, and creative skills, increased their knowledge about health careers, and improved their health literacy. The students produced three comic books this year: *Smoking Stinks*, *Double Cup Dilemma*, and *Mind Over Matter*.

The Disaster Information Management Research Center (DIMRC) incorporated If This, Then That (IFTTT) into its digital communication strategy. This tool automatically sends to Twitter updates about items added to the Disaster Lit database, thereby helping members of the disaster medicine and public health communities learn about new information quickly.



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# Lister Hill National Center for Biomedical Communications

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**Clement J. McDonald, MD**

*Director*

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The Lister Hill National Center for Biomedical Communications (LHC) is an intramural research and development division of the NLM. To fulfill its mission, LHC:

- captures, processes, distributes, and uses high quality medical imaging data;
- develops mobile health and emergency response tools;
- develops and promotes health information technology standards to facilitate their adoption, and the meaningful use of electronic health records (EHRs), public health, and research;
- conducts research and development in biomedical natural language processing;
- provides health-related information to enhance patient engagement; and
- trains the next generation of medical informaticians.

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## IMAGING DATA SCIENCE

LHC continued advanced imaging research to expedite the diagnosis and treatment of diseases, support disease research, and advance 3D image modeling.

LHC ported machine-learning software for malaria screening to smartphones, successfully completing the early-stage development phase support by the HHS Ventures Fund. The smartphone app improves diagnostic and quantitative accuracy by automatically counting the number of malaria-infected and uninfected red blood cells in a digital image captured by the phone's camera through the eyepiece of a microscope. The app then uses that data to compute the severity of the disease. LHC adapted deep learning (neuro-networks) to automate the counting, and, by using a training set

of 20,000 manually annotated cell images, improved the performance compared to previous machine learning methods.

LHC researchers also implemented two improvements to the pulmonary TB screening of chest X-rays of patients in an HIV-endemic region of northwest Kenya. Taken in a mobile truck, the X-ray images are evaluated using machine learning. LHC researchers developed a novel algorithm that improved the screening's diagnostic sensitivity. In addition, by replacing the computed radiography (CR) cassette previously used with a digital radiography (DR) cassette, LHC researchers improved diagnostic processing and efficiency. Unlike the CR cassette, the DR cassette can broadcast the images wirelessly and instantly to

an “automatic diagnosis” screening computer, which determines whether significant abnormalities are present. That diagnosis is then automatically uploaded to a website viewable via an encrypted connection on local WiFi.

This year LHC grew the Open-*i*<sup>®</sup> database to 3.7 million biomedical images extracted from 1.2 million PubMed Central articles. Open-*i* also ingested 80,000 images from NLM’s History of Medicine Division, as well as chest X-rays and

radiology reports from several Indianapolis hospitals and orthopedic illustrations from the University of Southern California.

This year LHC staff also worked on a prototype open-source library of programmable 3D anatomic organ and organ system images; published a paper comparing in-person dermatology examinations with high-resolution still images and videos; and published another paper reviewing popular tele-dermatology apps.

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## HEALTH IT TERMINOLOGY AND STANDARDS

LHC continued to help support, develop, and speed the adoption of universal standards for representing electronic medical data to the benefit of patient care, public health, and research.

In FY2016, staff helped organize two agreements, one between LOINC<sup>®</sup> and the Radiological Society of North America (RSNA) to create or modify new radiology LOINC terms, and the second between a number of organizations, including the Institute of Electrical and Electronic Engineering (IEEE) and the Centers for Medicare and Medicaid Services (CMS), to standardize their major assessment instruments.

LHC participated in a series of public meetings that led to laboratory instrument vendors agreeing to use a standard electronic format to map from their internal test codes to the appropriate LOINC test codes. Such standardization will save significant laboratory staff time and reduce lab

test coding errors. The meetings brought together representatives from LHC, LOINC, FDA, the CDC, the In Vitro Diagnostics (IVD) industry, and the IVD Industry Connectivity Consortium (IICC).

The RxNav browser and its APIs—for navigating RxNorm and other NLM-developed medication information resources— received over 800 million queries in 2016. Staff worked on the soft launch of RxNav 2.0 in beta, a JavaScript rewrite of the original Java WebStart program. The new version is mobile-responsive and can interact with RxClass.

LHC developed a Unified Code for Units of Measure (UCUM) validator and convertor. An open-source and web-enabled JavaScript widget, it can validate UCUM units individually typed in or a set of units uploaded in batch mode. The tool also converts values among alternate units of measure (e.g., from kilograms to pounds).

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## NATURAL LANGUAGE PROCESSING DATA SCIENCE

As part of an agreement with the FDA, LHC began to develop a natural language processing pipeline to extract drug-drug interactions from drug labels (i.e., package inserts) and to codify them in standard terminologies. The narrative form of the drug safety information must be converted into a coded form to effectively apply it to clinical decision-making.

LHC created a prototype for a free-text consumer health information and question-answering system. As part of training and evaluating the system, staff used it to annotate over 1,700 short questions submitted to MedlinePlus.

LHC worked with NCI to apply its text scrubber, which removes patient identifiers, to all pathology

reports in the 20 cancer registries associated with the Surveillance, Epidemiology, and End Results Program at the National Cancer Institute. The LHC text scrubber outperformed commercial products.

The Semantic Knowledge Representation project provides Semantic MEDLINE, a free tool that uses natural language processing and graph analysis to guide users to relevant MEDLINE citations. LHC staff simplified its database schema to optimize access. The Semantic MEDLINE predication database has more than 89,230,566 predications extracted from 26,737,750 MEDLINE citations.

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## BIG DATA ANALYSIS SCIENCE

LHC's work in big data analysis focused this year on Medicare data; on the relationship between Alzheimer's disease and anti-androgen therapy in prostate cancer patients; on metformin's effect on longevity; and on the impact of cardiovascular protective drugs on both Alzheimer's disease and dementia.

Researchers also studied how to improve the quality of large health care datasets for later research use. Specifically, in FY2016, LHC studied the output of the Achilles data quality tool maintained by the Observational Health Data Sciences and Informatics consortium, and helped improve Achilles by adding new data quality checks and measures.

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## INFORMATION AND KNOWLEDGE SERVICES

*Profiles in Science* added papers by Louis Sokoloff, the National Institute of Mental Health neuroscientist and physician who won the 1981 Albert Lasker Clinical Medical Research Award for his contributions to understanding and diagnosing

brain diseases. *Profiles in Science* now delivers 41 collections, 28,411 digitized items, and 151,360 digitized images via a new mobile-friendly design, which premiered this year.

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## TRAINING

In 2016, our Medical Informatics Training Program hosted 14 postdoctoral fellows (three MDs, six PhDs, four MD/PhDs and one nurse PhD), along with 19 visiting scientists and students from NLM-sponsored university training programs, medical schools, graduate schools, colleges, and high schools. Students came from 15 US states and nine countries, including Brazil, China, France, India, Iran, Japan, and the Philippines. Each participant spends between a few months and several years working on a research project under a mentor's guidance.

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# National Center for Biotechnology Information

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**David Lipman, PhD**

*Director*

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The National Center for Biotechnology Information (NCBI) was established by law in 1988 as biotechnology was taking off and lawmakers and scientists recognized the need to harness the large volume of data that would be generated by the genetic revolution.

To fulfill its mission, NCBI:

- creates automated systems for storing and analyzing molecular biology and genetic/genomic information and associating it with related information in the biomedical literature;
- performs research into advanced methods of analyzing and interpreting molecular biology data;
- facilitates the use of databases and software by researchers and healthcare personnel; and
- coordinates efforts to gather and disseminate biotechnology information worldwide.

NCBI has developed a vast array of resources, ranging from genetic/genomic databases to medical literature, analysis tools, and educational programs. These resources include about 40 integrated databases, such as the GenBank collection of all publicly available DNA sequences and PubMed and

PubMed Central, which comprise the biomedical and life sciences journal literature. Each day these and other NCBI resources are used by about 3.5 million people who download a median of 80 terabytes of data per day, the equivalent of more than 100,000 compact discs.

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## ANTIMICROBIAL RESISTANCE AND FOODBORNE PATHOGENS PROJECTS

NCBI is collaborating with federal partners and others to combat antimicrobial resistance and foodborne diseases, two serious public health problems that affect millions of Americans each

year. See “Genomic Data Combats Antibiotic Resistance, Foodborne Disease” (p. 6) for a fuller description of the substantial progress made on these projects this year.

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## GENOMIC, PROTEIN, AND CHEMICAL RESOURCES

In FY2016 NCBI introduced several new tools and enhancements to its genome, gene, protein, and chemical resources, including the following:

- Speeded processing of GenBank submissions via a pilot project that automated quality assurance checks and other functions.
- Released Magic-BLAST to map large sets of next-generation RNA or DNA sequencing runs against a whole genome or transcriptome.
- Created tools that enable BLAST analysis of specific whole genome sequencing projects.
- Redesigned the BLAST home page to improve navigation and facilitate access to BLAST services.
- Launched a web-based interactive multiple sequence alignment viewer for nucleotides and proteins capable of reading NCBI formats and imported MUSCLE-formatted alignments.
- Introduced ORFfinder, an open reading frame (ORF) finder that provides a graphical display of identified ORFs, includes options to download ORFs in different formats, and allows the user to further analyze ORFs using NCBI's SmartBLAST.
- Initiated Feature Location Service, a new backend search service for NCBI's Genome Data Viewer, a genome browser that displays RefSeq-annotated eukaryotic genome assemblies.
- Increased by 24% the number of top-level studies available through DbGaP, NCBI's Database of Genotypes and Phenotypes.
- Developed a Zika virus resource page to provide access to nucleotide and protein sequences from the outbreak.
- Corrected the species names for over 500 bacterial genomes following extensive review by the NCBI Taxonomy, GenBank, and RefSeq teams.
- Overhauled HistoneDB 2.0, which can be used to explore the diversity of histone proteins and their sequence variants in many organisms.
- Launched MutaBind, which evaluates the effects of variations and disease mutations on protein-protein interactions, predicts if a mutation disrupts an interaction, and calculates the change in binding affinity.
- Created iCn3D, a new 3D structure viewer that can show 3D structures, 2D interaction schematics, and 1D sequences on a single web page.
- Released a new version of the VAST+ dataset and web interface to include structural superpositions and derived data for structurally similar macromolecular complexes.
- Introduced SPARCLE, the Subfamily Protein ARChitecture Labeling Engine, which pulls together groups of proteins that share the same conserved domain architecture.
- Revamped the PubChem BioAssay Record page so it displays information provided by the contributor about the assay, along with annotations and links to tools that support data interpretation and analysis.

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## LITERATURE INFORMATION RESOURCES

NCBI continued to grow and improve its literature resources during the year. Achievements include:

- Developing a new data management system for PubMed, to be released early in FY2017, that will allow publishers to update and correct their citations.
- Adding to PubMed Central (PMC) *Mind and Mental Health Magazine*, the first title archived under the Biomedical Journal Digitization project, an effort to preserve and provide broader public access to NLM's historical journal collection.
- Increasing the number of articles available in PMC by 11% (4 million) and the number of articles retrieved each day by 15% (2.75 million).
- Signing agreements with the HHS Administration for Community Living and the Environmental Protection Agency to use PMC,



- bringing to nine the number of federal agencies using PMC for their public access programs.
- Adding to NCBI Bookshelf several important publications, including the working group reports from the International Agency for Research on Cancer and the World Health Organization Health Evidence Network Synthesis Reports.
- Including in PubMed Health resources to simplify systematic reviews, including a new “for researchers” section on the website.
- Collaborating with the HHS Agency for Healthcare Research and Quality to develop a PubMed filter to more readily identify literature focused on research methods.
- Integrating into PubMed Health the full text of over 150 guidance documents and studies of clinical effectiveness research methods.

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## MEDICAL GENETICS

NCBI supports medical genetics and precision medicine by developing resources that address a range of needs, including the validity of gene-disease associations, the transparency of genetic testing used for medical decision making, accurate interpretations about the impact of sequence variation on phenotypes, and evidence regarding the clinical utility of genetic information.

ClinVar archives both the reports of variants found in patient samples and the assertions made about the clinical significance of those variations. This year the database added almost 53,000 submissions representing more than 34,000 new

variants.

The Genetic Testing Registry, an international registry of orderable genetic tests for heritable disorders, somatic/cancer variation, and drug responses, grew to include information on more than 33,000 tests. Voluntarily provided by the testing labs, this information addresses the tests’ technical details as well as their clinical utility and validity.

Other medical genetics resources, including MedGen, GeneReviews, OMIM, and Medical Genetics Summaries, delivered a growing collection of articles that review practical information about genetic testing.

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## RESEARCH

NCBI’s Computational Biology Branch focuses on computational approaches to a broad range of fundamental problems in evolution, molecular biology, genomes, biomedical science, and bioinformatics. The branch conducts independent research and contributes to improving and developing NCBI resources.

Among numerous independent research projects this year, NCBI scientists developed a mathematical model of microbial genome evolution that predicted the existence of two qualitatively distinct classes of genes, one of which is characterized by extremely

high rates of evolution. The discovery shed light on the genetic diversity in the microbial world, indicating many more genes in the biosphere than previously suspected.

Other NCBI scientists collaborated with researchers from the University of California-Santa Cruz and National Chung Hsing University (Taiwan) to discover and structurally characterize the MshEN domain, a new c-di-GMP binding protein domain that regulates biofilm formation and contributes to the virulence of *Vibrio cholerae* and other bacterial pathogens.

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## TRAINING AND OUTREACH

Each day the NCBI website serves millions of users with a wide range of interests and backgrounds. To keep users abreast of updates, changes, and improved features, the NCBI User Services staff provided workshops, courses, and webinars, answered customer questions, and managed social media sites. Staff delivered courses and workshops both at NLM and at sponsoring institutions, and

produced nine short tutorials, seven NCBI NOW videos (from a Massive Online Open Course), and 28 full-length webinars. Tutorials, webinars, and workshops were uploaded to NCBI’s YouTube channel, where they averaged approximately 65 hours of viewing each day. NCBI also hosted several genomics hackathons focused on advanced bioinformatics analysis of next-gen sequencing data.

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# Extramural Programs

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**Valerie Florance, PhD**

*Director*

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The Extramural Programs Division (EP) administers extramural grant programs for NLM as authorized by the Medical Library Assistance Act and Public Health Service Act. EP's first grant awards were issued in 1965. The funds are expended as grants-in-aid and cooperative agreements to the extramural community in support of the Library's mission. Review and award procedures conform to NIH policies.

EP awards several categories of grants, all of which pertain to biomedical informatics and data science. Applications are received through parent NIH funding opportunity announcements (FOA) or through special FOAs issued by EP. Each year NLM makes new or continuing awards in five grant categories: Research Projects, Resources, Career Development, Research Career Training, and Small Business Research & Development.

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## GRANTS SUMMARY

EP's FY2016 base budget for grant awards—flat since FY2012—was \$42,317,138. This year NLM issued 125 grant awards totaling \$42,276,400. In addition to those core grant awards, NLM co-manages 17 grants from other NIH entities.

Per policy, NLM did not make new awards or launch new initiatives until the appropriations bill was signed into law on December 18, 2015, ending the continuing resolution under which the federal government began the fiscal year.

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## SUCCESS RATES

Success rates, which convey the likelihood of a project getting funded, are computed by dividing the number of awards in a fiscal year by the number of applications reviewed that year. Success rates were down in several programs in FY2016.

TABLE 1: SUCCESS RATE OF CORE NLM GRANT PROGRAMS, FY2012–2016

Grant Type	Activity Code	FY2012	FY2013	FY2014	FY2015	FY2016
Research <sup>1</sup>	R01	14%	16%	22%	24%	16.2%
	R21	11%	3%	16%	10%	7.5%
Career	K01	N/A <sup>3</sup>	N/A <sup>3</sup>	60%	17%	17%
	K99	26%	25%	25%	30%	N/A <sup>3</sup>
Resource	G13	8%	7%	13%	13%	3%

1. Research grants, funded with appropriated funds, support basic and applied informatics projects.
2. Resource grants use appropriated funds to support dissemination and management of health-related information.

3. No applications were received for this grant mechanism in this fiscal year.

## FY2016 HIGHLIGHTS

- NLM issued eight institutional grant awards for new cooperative agreement (UG4) awards supporting the National Network of Libraries of Medicine. The budget for these awards is reported by NLM Library Operations.
- NLM became the administrative home for 14 Big Data to Knowledge (BD2K) T32 training grants and several BD2K open educational resource grants on data management, curation, and annotation of biomedical big data. These grants were funded using BD2K funds.
- NLM awarded its first Ruth L. Kirschstein National Research Service Award (NRSA) pre-doctoral fellowship (F31)<sup>†</sup>.
- The Ohio State University hosted the annual NLM Informatics Training Conference June 27-28, 2016 in Columbus, Ohio. Approximately 275 people attended.
- EP reviewed applications for the NLM Informatics Training Programs. The new five-year awards will begin on July 1, 2017.
- EP program staff organized three talks by NLM grantees as part of the NLM Informatics Lecture Series:
  - Dr. Joshua Denny: “Use of Clinical Big Data to Inform Precision Medicine” (November 4, 2015)
  - Dr. Mark Craven: “Inferring Host-Pathogen Interactions from Diverse Data Sources” (March 9, 2016)
  - Dr. Kellie Archer: “Predicting an Ordinal Response Using Features from High-Throughput Genomic Assays” (June 15, 2016)

<sup>†</sup> The FY2015 report mistakenly identified the first Ruth L. Kirschstein National Research Service Award as being issued then. Applications were reviewed in FY2015. The fellowship was first awarded this year.

## GRANT PROGRAMS

NLM participates in two types of multi-institute grant programs: general and topical. General programs are fundamental components of NLM’s overall grant program. NLM participates selectively in topic-focused multi-institute funding announcements.

**TABLE 2: CORE ACTIVE GRANT PROGRAMS: NLM ONLY**

Announcement	Title	Expiration
PA-16-294	NLM Informatics Conference Grants (R13)	May 8, 2019
PA-17-090	NLM Administrative Supplements for Informationist Services in NIH-funded Research Projects (Administrative Supplement)	March 16, 2017
PAR-13-284	NLM Career Development Award in Biomedical Informatics (K01)	September 8, 2016
PAR-16-404	NLM Express Research Grants in Biomedical Informatics (R01)	September 8, 2019
PAR-16-417	NLM Grants for Scholarly Works in Biomedicine and Health (G13)	February 24, 2018
PA-16-309/308/306	NLM Information Resource Grants to Reduce Health Disparities (G08)	December 17, 2016

**TABLE 3: CORE ACTIVE GRANT PROGRAMS: NLM PARENT**

Announcement	Title	Expiration
PA-15-321	Research Grant Supplement to Promote Reentry in Health-Related Research (Administrative Supplement)	September 30, 2018
PA-15-322	Research Grant Supplement to Promote Diversity in Health-Related Research (Administrative Supplement)	September 30, 2018
PA-16-160	Research Project Grant (NIH Parent R01)	May 8, 2019
PA-16-161	NIH Exploratory/Developmental Research Grant Program (Parent R21)	May 8, 2019
PA-16-193	NIH Pathway to Independence Award (K99/R00)	May 8, 2019
PA-16-200	Academic Research Enhancement Award (AREA) (Parent R15)	May 8, 2019
PA-16-309/308/306	Ruth L. Kirschstein NRSA Individual Predoctoral Fellowships (F30/F31)	May 8, 2019
PAR-16-302/303	Small Business Innovations Research Grants (Parent SBIR R43/R44) (STTR R41/R42)	April 6, 2017

**TABLE 4: FY2016 OPERATING BUDGET REQUEST BY NIH ACTIVITY CODE**

Activity Code	NLM Awards (New & Continuing)	Non-NLM Awards (New & Continuing)	Funding from NLM EP
<b>DP1:</b> Pioneer Award		1	\$384,254 <sup>CF1</sup>
<b>DP5:</b> Early Independence Award		1	\$211,875 <sup>CF1</sup>
<b>F31:</b> NRSA Individual Predoctoral Fellowships	1		\$40,790
<b>G08:</b> Information Resource Grants to Reduce Health Disparities	4		\$384,093
<b>G13:</b> Scholarly Works in Biomedicine and Health	8		\$386,753
<b>K01:</b> Career Development Award in Biomedical Informatics	9		\$1,198,330
<b>K22:</b> NLM Independent Career Development Award for Biomedical Informatics	3		\$419,598

*(table continues)*

Activity Code	NLM Awards (New & Continuing)	Non-NLM Awards (New & Continuing)	Funding from NLM EP
<b>K99:</b> Pathway to Independence	2		\$88,767
<b>P20:</b> Research Center Grants		1	\$37,614 <sup>CF2</sup>
<b>R00:</b> Pathway to Independence	8		\$1,862,657
<b>R01:</b> Research Project Grants	52		\$20,701,987
<b>R13:</b> Conference Grants	5		\$91,705
<b>R15:</b> Academic Research Enhancement Award (AREA)	1		\$408,357
<b>R21:</b> Exploratory/Developmental Grants	6		\$1,194,791
<b>R25:</b> BD2K Research Education Award		5	\$0 <sup>CF1</sup>
<b>R41:</b> Small Business Technology Transfer (STTR)	1		\$224,972
<b>R43:</b> Small Business Innovation Research (SBIR)	2		\$369,366
<b>R44:</b> Small Business Technology Transfer (STTR)	1		\$491,587
<b>R56:</b> High Priority, Short-term Grants		1	\$280,000 <sup>CF3</sup>
<b>T15:</b> University Biomedical Informatics Research Training Programs	14	5	\$12,672,914 <sup>CF4</sup>
<b>U01:</b> Collaborative Research (Howard/Hopkins Collaboration) NIH SBIR/STTR Research Evaluation and Commercialization Hub (REACH)		1	\$3,173 <sup>CF5</sup>
<b>U24:</b> Cooperative Agreement Resource Grants		1	\$250,000 <sup>CF6</sup>
<b>UG4:</b> National Network of Libraries of Medicine	8		\$0 <sup>CF7</sup>
<b>EP budget excluding TAPS &amp; Operations</b>	<b>125</b>	<b>16</b>	<b>\$42,276,400</b>

CF. Grant co-funded by NLM/EP and the NIH or NLM entity indicated:

- |                                    |                                    |
|------------------------------------|------------------------------------|
| 1. NIH Common Fund (NIH OD)        | 5. NHLBI (Heart, Lung and Blood)   |
| 2. NCI (Cancer)                    | 6. NCATS (Translational Sciences)  |
| 3. NIGMS (General Medical)         | 7. NLM LO (NLM Library Operations) |
| 4. NIDCR (Dental and Craniofacial) |                                    |

TABLE 5: ACTIVE FY2016 CO-FUND GRANTS WITH NLM PARTICIPATION

Activity Code	NLM Awards (New & Continuing)	NLM Awards (New & Continuing)	Co-Funders Contribution
<b>DP1:</b> Pioneer Award		1	\$384,253 <sup>CF1</sup>
<b>DP5:</b> Early Independence Award		1	\$211,875 <sup>CF1</sup>
<b>P20:</b> Research Center Grants		1	\$179,297 <sup>CF2</sup>
<b>R01:</b> Research Project Grants	2	7	\$417,061 <sup>CF3</sup>
<b>R25:</b> BD2K Research Education Award		5	\$268,244 <sup>CF1</sup>
<b>T15:</b> University Biomedical Informatics Research Training Programs		5	\$2,615,566 <sup>CF4</sup>
<b>U01:</b> Collaborative Research (Howard/Hopkins Collaboration) NIH SBIR/STTR Research Evaluation and Commercialization Hub (REACH)		1	\$996,021 <sup>CF1</sup>

(table continues)



Activity Code	NLM Awards (New & Continuing)	NLM Awards (New & Continuing)	Co-Funders Contribution
<b>U24:</b> Cooperative Agreement Resource Grants		1	\$2,605,290 <sup>CF6</sup>
<b>U54:</b> Cooperative Agreement Specialized Center		2	\$394,056 <sup>CF8</sup>
<b>UG4:</b> National Network of Libraries of Medicine	8		\$11,951,521 <sup>CF7</sup>
<b>Co-funded Totals</b>	<b>10</b>	<b>25</b>	<b>\$20,023,184</b>

CF Grant co-funded by NLM/EP and the NIH or NLM entity indicated:

- |                                    |                                    |
|------------------------------------|------------------------------------|
| 1. NIH Common Fund (NIH OD)        | 5. NHLBI (Heart, Lung and Blood)   |
| 2. NCI (Cancer)                    | 6. NCATS (Translational Sciences)  |
| 3. NIGMS (General Medical)         | 7. NLM LO (NLM Library Operations) |
| 4. NIDCR (Dental and Craniofacial) |                                    |

**TABLE 6: NLM GRANT PORTFOLIO: NEW AND CONTINUING AWARDS BY NIH GRANT MECHANISM**

Grant Type	Activity Code	New FY2016	Continuing FY2016
<b>Research</b>	R01	12	41
	R21	3	3
	R13	2	3
	R15	1	0 <sup>3</sup>
	DP1	0 <sup>3</sup>	1
	R56	0 <sup>3</sup>	1
	UG4	8	N/A <sup>2</sup>
<b>Resource</b>	G08	0 <sup>3</sup>	4
	G13	1	7
	Administrative Supplement	9 <sup>1</sup>	N/A <sup>2</sup>
<b>Training Grants</b>	T15	0 <sup>3</sup>	14
	K99/R00	0 <sup>3</sup>	9
	K01	5	4
	K22	0 <sup>3</sup>	3
	R25	0 <sup>3</sup>	5
	T32	10	4
<b>SBIR/STTR</b>	R43	2	0 <sup>3</sup>
	R44	1	0 <sup>3</sup>
<b>Fellowships</b>		1	N/A <sup>2</sup>
<b>Total</b>		46 <sup>1</sup>	99

- |   |   |
|---|---|
| 1. Administrative Supplements are attached to the parent grant and not counted as separate awards in the NLM portfolio. | 3. No applications received for FY2016. |
| 2. Grant mechanism not available to receive or continue applications.   |   |

TABLE 7: NLM FY2016 AWARDS BY INVESTMENT AREA†

Investment Area	Clinical Informatics	Training	Bioinformatics	Information Science	Public Health Informatics	Translational Informatics	Consumer Health Informatics
	48	33	14	31	2	13	5
	14		4	12		5	1
<b>All FY2016 Awards</b>	\$14,555,634	\$12,640,532	\$4,235,005	\$16,285,864	\$943,613	\$3,116,951	\$1,062,461
Total:	\$52,840,060						
<b>New Grants</b>	\$3,885,877	\$0	\$942,538	\$12,888,695	\$0	\$981,721	\$168,375
Total:	\$18,837,206						

† Investment area funding total includes co-funding dollars for the 8 UG4 grants (National Network of Libraries of Medicine) and the 5 R25 grants (BD2K Research Education).

TABLE 8: FY2016 PORTFOLIO OF FUNDED GRANTS BY NIH MECHANISM GROUPINGS

Activity Code	Number of Awards	Amount
<b>Research Project Grants</b> (R01, R21, R00, R15, R56, DP1, DP51)	68	\$24,552,046
<b>SBIR/STTR</b> (R41, R43, R44)	4	\$1,085,925
<b>Other Research—Research Careers</b> (K99, K22, K01)	15	\$1,706,695
<b>Other Research—Other</b> (G08, G13, R13, R25, R56, U24)	22	\$1,112,551
<b>Training—Institutional</b> (T15, T32, F31)	29 <sup>1</sup>	\$12,681,322 <sup>2</sup>
<b>National Network of Libraries of Medicine</b> (UG4)	8	\$11,951,521
<b>Exploratory Center</b> (P20)	0 <sup>3</sup>	\$37,614
<b>EP Grant budget excluding TAPS and Operations</b>	<b>146<sup>1</sup></b>	<b>\$52,840,060</b>

1. Figures include all awards from appropriated funds, plus awards funded by other NIH Institutes and Centers.
2. Not NLM Extramural Programs fund
3. NLM is not the administering institute for this grant; therefore, this award is not counted as an NLM grant.

TABLE 8: PAN-NIH PROJECTS AND INTERAGENCY COLLABORATIONS

Award	NLM Cost	Awardee
Informationist Services Supplement (R01, P20)	\$368,077	Nine supplemental awards to NIH-funded Research Projects
NIH Director's Early Independence Awards (DP5) <sup>CF</sup>	\$211,875	New York University School Medicine: Impact of Racially Targeted Food and Beverage Ads on Adolescent Behavior

(table continues)

Award	NLM Cost	Awardee
NIH Director's Pioneer Award (DP1) <sup>CF</sup>	\$384,253	Stanford University: Enabling Technologies for Human-Machine Hybrid Tissues
Small Business Innovation Research (P20) <sup>CF</sup>	\$37,965 <sup>1</sup>	Howard University: Howard/Hopkins Intercenter Collaboration in HPV-Associated Cancer Studies

CF. Co-funded

1. NLM's share of \$659,846 Phase II award

TABLE 9: INTERAGENCY AGREEMENTS AND FUNDING

Awardee	Amount	Source
Dr. Paula Bates (NLM Grantee)	\$3,173	Co-funded with NHLBI for Research Evaluation and Commercialization Hub (REACH) for Small Business and Innovation Research (SBIR) support
Protein Sequence Databank, Rutgers University (PDB)	\$75,000	Co-funded with the National Science Foundation and other NIH Institutes and Centers.

## SHARED FUNDING FOR RESEARCH

In FY2016, NLM co-funded the following research efforts:

- Nine informationist supplements to support the grants of six other NIH Institutes
- Small Business Technology Transfer Award administered by the National Institute of Mental Health
- National Heart, Lung, and Blood Institute at the University of Louisville (known as The Excite Program: Expediting Commercialization, Innovation, Translation & Entrepreneurship)

TABLE 13: TOP FIVE GRANTEES BY PUBLICATIONS

Grantee	Publication count
Hripcsak, George M.	56
Uzuner, Ozlem	27
Moore, Jason H.	22
Altman, Russ B.	22
Craven, Mark W.	21

TABLE 14: TOP FIVE JOURNALS FOR NLM GRANTEES' PUBLISHED WORKS

Journal Title	Publication count
<i>Journal of Biomedical Informatics</i>	45
<i>Journal of the American Medical Informatics Association (JAMIA)</i>	24
<i>Pacific Symposium on Biocomputing</i>	12
<i>PLoS One</i>	11
<i>Scientific Reports</i>	10

(table continues)

TABLE 15: TOP FIVE ARTICLES CITED

Article Citation	Citation count
Hunter, Lawrence E. and biomedical informatics training team. “QIIME allows Analysis of High-Throughput Community Sequencing Data.” <i>Nature Methods</i> (2010): 7(5), 335-336.	1596
Craven, Mark and biomedical informatics training team. “Mauve: Multiple Alignment of Conserved Genomic Sequence with Rearrangements.” <i>Genome Research</i> (2004): 14(7), 1394-1403.	651
Hripcsak, George M. and biomedical informatics training team. “ARACNE: An Algorithm for the Reconstruction of Gene Regulatory Networks in a Mammalian Cellular Context.” <i>BMC Bioinformatics</i> (2006): 7 Suppl 1, S7.	549
Hahn, Lance W.; Ritchie, Marylyn D.; Moore, Jason H. “Multifactor Dimensionality Reduction Software for Detecting Gene-Gene and Gene-Environment Interactions.” <i>Bioinformatics</i> (2003): 19(3), 376-382.	537
Eichler, Evan E.; Flint, Jonathan; Gibson, Greg; Kong, Augustine; Leal, Suzanne M.; Moore, Jason H.; Nadeau, Joseph H. “Missing Heritability and Strategies for Finding the Underlying Causes of Complex Disease.” <i>Nature Reviews: Genetics</i> (2010): 11(6), 446-450.	476

## TRAINING AND CAREER AWARDS

University-based Biomedical Informatics Research Training Programs (T15)

NLM remains the principal US source of support for research training in biomedical informatics and data science. EP provides both institutional training support and individual career transition support.

Five-year institutional training grants support predoctoral, postdoctoral, and short-term informatics research trainees at 14 university-based programs across the country.

In FY2016, NLM supported 109 predoctoral and 57 postdoctoral fellowship slots in two different trainee award types. In addition, 14 national BD2K training programs supported a total of 73 predoctoral trainees. NLM also supported two predoctoral and seven postdoctoral trainees in dental informatics, with the National Institute of Dental and Craniofacial Research (NIDCR) supporting three NLM training programs.

TABLE 16: BIG DATA TO KNOWLEDGE (BD2K) GRANTS (NIH COMMON FUND)

Award	NLM Cost	Awardee
Open Educational Resources for Sharing, Annotating, and Curating Biomedical Big Data (R25)	\$0	<ul style="list-style-type: none"> <li>- Georgetown University</li> <li>- Harvard Medical School</li> <li>- Johns Hopkins University</li> <li>- New York University School of Medicine</li> <li>- Rutgers University</li> </ul>
Predocutorial Training in Biomedical Big Data Science (T32)	\$0	<ul style="list-style-type: none"> <li>- Dartmouth College</li> <li>- Harvard School of Public Health</li> <li>- Northwestern University at Chicago</li> <li>- Pennsylvania State University</li> <li>- Stanford University</li> <li>- University of North Carolina, Chapel Hill</li> <li>- University of California, Berkeley</li> <li>- University of California, Los Angeles</li> <li>- University of Missouri, Columbia</li> <li>- University of Texas, Austin</li> <li>- University of Virginia</li> <li>- University of Washington</li> <li>- University of Wisconsin, Madison</li> <li>- Vanderbilt University</li> </ul>

Award	NLM Cost	Awardee
NLM Institutional Training Grants for Research Training in Biomedical Informatics (T15 supplement)	\$0	– Columbia University Health Sciences

## GRANT REVIEW ACTIVITIES

TABLE 17: GRANT REVIEW BY PANEL

Panel Type	Applications reviewed FY2015	Applications reviewed FY2016	Percent reviewed FY2016
NLM Biomedical Library and Informatics Review Committee	107	114	42%
NLM Special Emphasis Panels	105	115	42%
NIH Center for Scientific Review	50	45	16%
<b>Total applications reviewed</b>	<b>262</b>	<b>274</b>	<b>100%</b>

## NLM NEW GRANTS AWARDED IN FY2016

### Research Projects (R01)

Garmire, Lana X. (New Investigator)  
An Integrative Bioinformatics Platform with Application in Single Cancer Cells  
1 R01 LM012373-01  
University of Hawaii at Manoa

Janssens, A. Cecile (New Investigator)  
Novel Citation-Based Literature Search Method: Application to Meta-analyses  
1 R01 LM012372-01  
Emory University

Kleinberg, Samantha  
BIGDATA: Causal Inference in Large-scale Time Series  
2 R01 LM011826-04  
Stevens Institute of Technology

Kumar, Sudhir  
Evolutionary Bioinformatics of Tumor Profiles  
1 R01 LM012487-01  
Temple University

Miller, Grover P. (New Investigator)  
Computationally Modeling the Impact of Ontogeny on Drug Metabolic Fate  
1 R01 LM012482-01  
University of Arkansas for Medical Sciences

Miller, Kristen E. (New Investigator)  
Signaling Sepsis: Developing a Framework to Optimize Alert Design  
1 R01 LM012300-01A1  
Christiana Care Health Services, Inc.

Ogunyemi, Omolola I.  
Predicting Diabetic Retinopathy from Risk Factor Data and Digital Retinal Images  
1 R01 LM012309-01A1  
Charles R. Drew University of Medicine and Science

Patek, Stephen D.  
CloudConnect: Consumer Health IT for Enhanced Treatment of Chronic Illness  
1 R01 LM012090-01A1  
University of Virginia

Popescu, Mihail (New Investigator)  
Linguistic Summarization of Sensor Data for Early Illness Recognition in Eldercare  
1 R01 LM012221-01A1  
University of Missouri, Columbia

Smalheiser, Neil R.  
Text Mining Pipeline to Accelerate Systematic Reviews in Evidence-Based Medicine  
2 R01 LM010817-05A1  
University of Illinois at Chicago

Swamidass, Sanjay J. (New Investigator)  
 Data and Tools for Modeling Metabolism and  
 Reactivity  
 1 R01 LM012222-01  
 Washington University

Xu, Xiaoyin  
 Computer Aided Diagnosis of Cancer Metastases in  
 the Brain  
 1 R01 LM012434-01  
 Brigham and Women's Hospital

### **Exploratory/Developmental Research (R21)**

Kavuluru, Venkata N.  
 From Syntactic Relations to Semantic Predications:  
 Porting Open Information Extraction to Biomedicine  
 1 R21 LM012274-01  
 University of Kentucky

McCoy, Allison B.  
 Electronic Health Record Safety: Developing  
 Framework-Based Measures and Identifying Best  
 Practices  
 1 R21 LM012448-01  
 Tulane University

Lambert, Christophe G.  
 A Microaggregation Framework for Reproducible  
 Research with Observational Data: Addressing  
 Biases while Protecting Personal Identities  
 1 R21 LM012389-01  
 University of New Mexico Health Sciences Center

### **High Priority, Short Term Project Awards**

Wright, Melanie C.  
 Right Place, Right Time: Information Design to  
 Support Decisions in Acute Care  
 5 R56 LM011925-02  
 Saint Alphonsus Regional Medical Center

### **NLM Informatics Conference (R13)**

Sarkar, Indra N.  
 New Paths for Biomedical Informatics: A Mini-  
 Symposium for High School Scholars  
 1 R13 LM012293-01  
 American Medical Informatics Association

Thakor, Nitish V.  
 2016 Advanced Health Informatics Gordon Research  
 Conference  
 1 R13 LM012403-01  
 Gordon Research Conferences

### **Academic Research Enhancement Award (R15)**

Richesson, Rachel L.  
 Quantifying System and Data Readiness for  
 Automated Clinical Decision Support  
 1 R15 LM012335-01A1  
 Duke University



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**NLM Grants for Scholarly Works in Biomedicine and Health (G13)**

Vexler, Albert  
Modern Empirical Likelihood Methods in  
Biomedicine and Health  
1 G13 LM012241-01  
State University of New York at Buffalo

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**Regional Medical Libraries for the National Network of Libraries of Medicine (UG4)**

Bardyn, Tania P.  
NN/LM Region 6 RML, NN/LM Web Services Office  
(NWSO), NN/LM Evaluation Office (NEO)  
University of Washington  
RFA-LM-15-003  
1 UG4 LM012343-01  
University of Washington

Burgard, Daniel Eric  
Creating Solutions for a Healthier Community: A  
Proposal to Host NN/LMs SCR RML  
1 UG4 LM012345-01  
University of North Texas Health Sciences Center

Consales, Judith C.  
Regional Medical Library for the National Network of  
Libraries of Medicine Region 7  
(Arizona, California, Hawaii, Nevada, and US  
Territories in the Pacific Basin)  
1 UG4 LM012341-01  
University of California, Los Angeles

Epstein, Barbara A.  
National Network of Libraries of Medicine  
MidAtlantic (Region 1) and Web Services Office  
1 UG4 LM012342-01  
University of Pittsburgh

Piorun, Mary E.  
National Network of Libraries of Medicine New  
England (Region 8) and Public Health Coordination  
Office  
1 UG4 LM012347-01  
University of Massachusetts Medical School

Shipman, Jean P.  
National Network of Libraries of Medicine  
MidContinental (Region 4) and National Training  
Office  
1 UG4 LM012344-01  
University of Utah

Tooev, Mary  
Southeastern/Atlantic Regional Medical Library  
1 UG4 LM012340-01  
University of Maryland, Baltimore

Walton, Linda J.  
National Network of Libraries of Medicine Greater  
Midwest (Region 3)  
1 UG4 LM012346-01  
University of Iowa

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**NLM Career Development Award in Biomedical Informatics (K01)**

Banerjee, Tanvi  
Managing Dementia through a Multisensory Smart  
Phone Application to Support Aging in Place  
1 K01 LM012439-01  
Wright State University

Frost, Hildreth R.  
Tissue-specific Gene Set Testing  
1 K01 LM012426-01  
Dartmouth College

Sirota, Marina  
Elucidating the Role of the Genetic and  
Environmental Determinants of Preterm Birth Using  
Integrative Computational Approaches  
1 K01 LM012381-01  
University of California, San Francisco

Yao, Lixia  
A Research Opportunity Index to Measure  
Biomedical Research Disparities across the Disease  
Landscape  
1 K01 LM012102-01A1  
University of North Carolina, Charlotte

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**Small Business Innovations Research (SBIR) and Small Business Technology Transfer (STTR) Awards (R41, R43, R44)**

Kloppenborg, Brian  
Accelerating Biomedical Image Processing using  
Massively Parallel Processors  
1 R43 LM012359-01  
Accelereyes, LLC

Riskin, Daniel J.  
Leveraging Advanced Clinical Phenotyping to  
Enhance Problem Lists and Support Value-based  
Healthcare  
1 R43 LM012357-01A1  
VMT, Inc.

Welch, Brandon M.  
Expanding Teleconsent Capabilities to Improve  
Clinical Research Recruitment  
1 R41 LM012547-01A1  
Doxy.me, LLC

Williams, Jayne A.  
A Search Engine for Heterogeneous Information  
Needs in the Clinical Workflow  
2 R44 LM011590-02  
Medsocket of Missouri, Inc.

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**NIH Big Data to Knowledge (BD2K) Grants**

Altman, Russ B.  
Biomedical Data Science Graduate Training at  
Stanford  
1 T32 LM012409-01  
Stanford University

Amos, Christopher I.  
Quantitative Biomedical Sciences at Dartmouth  
1 T32 LM012204-01A1  
Dartmouth College

Daniels, Michael J.  
Predoctoral Training in Biomedical Big Data Science  
1 T32 LM012414-01A1  
University of Texas, Austin

Malin, Bradley A.  
BIDS: Vanderbilt Training Program in Big Biomedical  
Data Science  
1 T32 LM012412-01  
Vanderbilt University

Newton, Michael A.  
Bio-Data Science Training Program  
1 T32 LM012413-01A1  
University of Wisconsin, Madison

Papin, Jason  
Transdisciplinary Big Data Science Training at UVA  
1 T32 LM012416-01  
University of Virginia

Quackenbush, John  
Statistical and Quantitative Training in Big Data  
Health Science  
1 T32 LM012411-01A1  
Harvard School of Public Health

Ritchie, Marylyn D.  
Penn State Biomedical Big Data to Knowledge  
(B2D2K) Training Program  
1 T32 LM012415-01  
Pennsylvania State University

Shyu, Chi-Ren  
Massive and Complex Data Analytics Pre-Doctoral  
Training in One Health  
1 T32 LM012410-01  
University of Missouri, Columbia

Vanderlaan, Mark J.  
Biomedical Big Data Training Program at UC  
Berkeley  
1 T32 LM012417-01  
University of California, Berkeley

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**Ruth R. Kirschstein NRSA Individual Predoctoral Fellowship**

Mallory, Emily K.  
Integrating Literature and Experimental Data for  
Druggability Methods  
1 F31 LM012354-01  
Stanford University

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# Office of Computer and Communications Systems

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Ivor D'Souza

Director

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The Office of Computer and Communications Systems (OCCS) provides efficient, cost-effective computing and networking services, application development, and technical advice and collaboration in information sciences.

OCCS provides NLM's computer networking backbone, connects to external networks, manages the DHS and HHS-approved "unrestricted Trusted Internet Gateway" point-of-presence, handles the interconnections to divisional networks within the NLM, and operates both the NLM Computer Center onsite in Bethesda and the offsite facility in Sterling, Virginia.

OCCS helps coordinate, integrate, and standardize the array of computer services available across NLM. Staff create, maintain, and enhance applications and websites for controlled medical terminology systems, consumer and public health, and outreach programs. OCCS also engineers systems that provide many different types of medical data for the public. These applications and websites are designed to be secure, user-friendly, and easily accessible by all.

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## CONSUMER AND PUBLIC HEALTH

OCCS introduced support for image content data types within the Digital Repository, allowing the Images from the History of Medicine collection to migrate to the repository this year. In addition, the Image Interoperability Framework (IIIF) API 2.0, now active within the Digital Repository, provides easy and fast viewing of rich images, including pan, zoom, and full screen, and allows partner organizations to publish images and related metadata.

OCCS staff successfully merged two databases, the Directory of History of Medicine Collections

and the Guide to Oral History Collections, to create a more seamless, integrated user experience and reduce labor and maintenance costs. In addition, because of enhancements that accompanied the merger, libraries, archives, and museums can contribute their data directly to the database, no longer needing to submit information via email for data entry at NLM.

Working with Library Operations, OCCS developed a front-end user interface for the NLM Learning Resources database and an API for

automated access to these training resources. The database provides a one-stop shop for instructional videos, webinars, tutorials, and other materials to educate the public on the use of NLM products and services.

OCCS improved IndexCat to give users the ability to retrieve detailed information about journal title abbreviations.

OCCS partnered with NLM's National Information Center on Health Services Research and Health Care Technology (NICHSR) to develop a federated

search across their public health research resources: HSRR (Health Services and Sciences Research Resources), HSRIC (Health Services Research Information Central), HSRProj (Health Services Research Projects in Progress), and PHPartners (Partners in Information Access for the Public Health Workforce). This single point of access helps users discover information more quickly and easily while also giving them a broader view of what NICHSR provides.

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## MEDICAL TERMINOLOGY

OCCS supported two new releases of the Unified Medical Language Systems (UMLS). Released in November, UMLS 2015AB included more than 3.2 million concepts; 12.8 million unique concept names from over 190 source vocabularies; and 22 new sources [NCI Content Archive Resource Exchange Lexicon (Carelex); Human Phenotype Ontology; Manufacture of Vaccines; and 19 new LOINC translation sources]. Six months later, UMLS 2016AA delivered more than 3.25 million concepts; nearly 13 million unique concept names from over 190 source vocabularies; three additional sources (Clinical Classifications Software; NANDA-I Taxonomy II; LOINC German, Austria Translation); and two new Content Views.

OCCS applied Oracle standby database technology to ensure reliable access to the UMLS database in the event of a disaster.

Within the RxNorm editing system, OCCS created new tools that provide a more accurate picture of drugs available on the US market and their National Drug Codes. The new functionality helps refine the accuracy of the data, provides feedback to source providers on the inaccuracies in their data, and reduces the time spent editing each drug code containing conflicting or obsolete information.

OCCS also reduced editing time by re-organizing content within the MeSH editing system. OCCS staff expedited the addition of Zika-related terms in

MeSH and downstream projects, added new content to MeSH sub-systems, and updated content in the Data Creation and Maintenance System (DCMS), MeSH browser, and MeSH-MARC.

OCCS installed a Supplement Mapping Module within the Connect Mappings Management System. This new module allows Library Operations to manage supplement mappings more frequently and automates updates to these mappings for OCCS staff.

OCCS added the ability to map LOINC codes to MedlinePlus health topics. Over time, as more lab codes are mapped to health topics, this enhancement will increase the number of lab codes that return search results.

OCCS automatically mapped OLDMEDLINE terms to MeSH terms, saving hours of indexing, and processed OLDMEDLINE citations as follows:

- MeSH terms: 5.5 million records added (118% increase from FY2015)
- Subheadings: 990,000 records added (21% increase from FY2015)

OCCS enhanced NLM classification capabilities by implementing auto-import of “See Reference” and “See From” terms from MeSH and automating reports that map MeSH terms to classification numbers, notably reducing the workload for Technical Services Division staff.

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## NLM IT INFRASTRUCTURE AND CYBERSECURITY

OCCS implemented software to monitor network performance and capture differences between IPv4 and IPv6. Linked to NLM's high profile web applications, the new tool helps identify and monitor

shifts to IPv6 on both the internet and internet2.

OCCS worked with the NIH Center for Information Technology to facilitate the NLM-wide migration from Adobe Connect to Cisco WebEx

web conferencing service. The change saves NLM approximately \$352,000 annually.

OCCS increased bandwidth for NLM private computing resources by replacing firewalls. This upgrade raised private firewall bi-directional throughput by 150% (from 8 Gbps to 20 Gbps) for internal network segments. The upgrade will accommodate increased usage and new equipment.

OCCS enhanced NLM LAN port security management by automating formerly manual processes, including MAC verification and VLAN assignment. The enhancement reduced labor by 114 hours per year, resulting in approximately \$10,000 of savings annually.

OCCS upgraded the application load balancing hardware to a newer version. This upgrade increased SSL transactions per second by a factor of 20 (from 500 TPS to 10,000 TPS), enabled broader use of strong encryption keys, and multiplied network

throughput by five (2Gbps to 10Gbps).

The installation of new hardware also increased the capacity of the OCCS server virtualization environment from 16 to 24 cores. This increase will accommodate growth and improve performance when accessing large files or during peak demand.

Enabling single sign-on across OCCS applications improved NLM's overall security profile, reduced redundant authentication mechanisms, and simplified user access.

For NIH internal use only, OCCS introduced a web portal to training materials on application security. Developers can use the resources available through the portal to learn secure coding practices and how to prevent common application vulnerabilities. OCCS also shared the portal with NIH application developers.

# Administration

Todd D. Danielson

Associate Director

**TABLE 1: FINANCIAL RESOURCES AND ALLOCATIONS, FY2016**

Program Area	Dollars in Thousands
Extramural Program	\$ 56,925
Intramural Programs	325,862
Library Operations	(80,865)
Computer and Communication Systems	(37,806)
Lister Hill National Center for Biomedical Communications	(37,893)
National Center for Biomedical Information	(149,358)
Specialized Information Services	(19,939)
Research Management and Support	14,352
Total Appropriation	397,138
Plus: Reimbursements	28,810
<b>Total Resources</b>	<b>\$425,948</b>

NOTE: Additional funding totaling \$3 million for ClinicalTrials.gov was received from the NIH Institutes and Centers in FY2016.

**TABLE 2: FULL-TIME EQUIVALENTS, FY2016 (ACTUAL)**

Office/Division	FTE
Office of the Director	6
Office of Health Information Programs Development	5
Office of Communication and Public Liaison	10
Office of Administration	53
Office of Computer and Communication Systems	40
Extramural Programs	21
Lister Hill National Center for Biomedical Communications	60
National Center for Biomedical Information	296
Specialized Information Services	39
Library Operations	242
<b>Total FTEs</b>	<b>772</b>

**TABLE 3: APPOINTMENTS**

Name	Date
<b>Patricia Flatley Brennan, RN, PhD</b> Director <i>Office of the Director</i>	August 2016

**TABLE 4: DEPARTURES AND RETIREMENTS**

Name	Date
<b>Steven Phillips, MD</b> Associate Director <i>Specialized Information Services</i>	November 2015
<b>Michael Ackerman, PhD</b> Assistant Director for High Performance Computing and Communications <i>Lister Hill National Center for Biomedical Communications</i>	January 2016
<b>Michael North</b> Head, Rare Books and Early Manuscripts Section <i>History of Medicine</i>	March 2016
<b>Martha Fishel</b> Chief, Public Services Division <i>Library Operations</i>	June 2016
<b>Deirdre Clarkin</b> Deputy Chief, Public Services Division <i>Library Operations</i>	August 2016
<b>John Kilbourne, MD</b> Head, Medical Subject Headings Section <i>Library Operations</i>	August 2016
<b>Gale Dutcher</b> Deputy Associate Director <i>Specialized Information Services</i>	September 2016



TABLE 5: DIRECTOR'S EDUCATION FUND

Table 5: Institutions	Enrollees
American University	1
Boston University	1
FAES at NIH	1
George Mason University	1
George Washington University	3
Howard University	1
Johns Hopkins School of Public Health	1
Strayer University	2
Syracuse University	1
University of Maryland	7
Washington Adventist University	1
USDA Graduate School	1
<b>Total Staff Enrolled</b>	<b>21</b>
<b>Total Courses</b>	<b>33</b>

TABLE 6: NLM ASSOCIATE FELLOWS, 2016–2017

Name and University
<b>Megan Fratta</b> MLS, University of Maryland BA, University of Maryland, Baltimore County
<b>Kendra Godwin</b> MLIS, University of California, Los Angeles BA, Lewis & Clark College
<b>Tyler Moses</b> MLS, Texas Woman's University MS, Texas Woman's University BA, Texas A&M University, San Antonio
<b>Candace Norton</b> MLS, Texas Woman's University BA, Hollins University

## AWARDS: NLM AND NIH

Award	Recipient	Accomplishment
<b>The Regents Award for Scholarship or Technical Achievement</b>	Dr. Alla Keselman	For sustained excellence in research, scholarship, and mentoring in the field of health information for the public, and, in particular for co-editing the book <i>Meeting Health Information Needs Outside of Healthcare: Opportunities and Challenges</i> .
	John P. Doyle	For providing excellent technical and programmatic oversight of the development and growth of the NLM Digital Collections repository.
	Dr. William A. Klimke	For leading and overseeing the microbiological aspects of the Bacterial Pathogens Project, coordinating efficient exchanges of samples among federal and state partners, with subsequent significant benefits for public health.
<b>Frank B. Rogers Award</b>	James G. Mork	For his contribution to the Medical Text Indexer (MTI) program and the substantial improvement MTI has brought to NLM indexing activities.
	Todd D. Danielson	For preventing and solving problems and providing wise advice to NLM staff at all levels.
	Karen J. Robak	For extraordinary dedication and sustained high performance that has enhanced the quality and reliability of NLM computer operations.
<b>NLM Director's Honor Award</b>	Cuong K. Tran	For his expertise and dedication in managing the Title 42 appointment process for scientists and fellows in the National Center for Biotechnology Information.
	Dr. Wanda Whitney	For important contributions to language access planning and implementation at NLM and NIH.

(table continues)

Award	Recipient	Accomplishment
<b>Phillip C. Coleman Award</b>	Dr. Lon D. Phan	For his effective coaching and mentoring of team members in the dbSNP group.
	Nicole C. Scott	For her enthusiastic and dedicated mentorship of staff and students to improve their skills and gain experience essential to professional development.
<b>NIH Merit Award</b>	Annmarie A. Carr	In recognition of ongoing, creative actions to assure that the remotely located Extramural Programs Division offices are secure, organized, energy efficient, and supported by state-of-the-art technologies.
	Brooke A. Dine	For exceptional contributions to NLM's effective presence on the World Wide Web.
	Steven P. Emrick	For his exceptional contributions to NLM's key role in delivering terminologies for health care in the United States.
	Kevin L. Gates	For his leadership in promoting the implementation of the next-generation Internet Protocol (IPv6) at the NIH, and leading the NLM transition to the NIH unified communications and collaboration environment.
	Margaret V. Slovikosky	In recognition of her exemplary leadership and effective management of the administrative activities of the Lister Hill National Center for Biomedical Communications.
	Patricia Tuohy	In recognition of her leadership of the NLM's award-winning and internationally-recognized Exhibition Program.
	Lorretta J. Turnage	For her dedication and exceptional contributions in managing the acquisition of modern biomedical monographic literature for the National Library of Medicine's collection.
<b>NIH Director's Award</b>	Dr. Sameer K. Antani	For exemplary leadership and creative engineering in developing an automated chest X-ray screening system for tuberculosis and deploying it in Africa.
	Dr. George R. Thoma	For exemplary performance while demonstrating significant leadership, skill, and ability in serving as a mentor.
	<i>Evolutionary Genomics Research Group</i> Dr. Eugene V. Koonin Dr. Kira S. Makarova Dr. Sergey A. Shmakov Dr. Yuri I. Wolf	For their work on discovery and functional classification of diverse Class 2 CRISPR-Cas systems.
	<i>NIH Disaster Research Response Group</i> Stacey J. Arnesen Cynthia B. Love	For outstanding contributions to the development of an innovative research program to address human health effects of natural and man-made disasters.
	<i>NIH-Wide Strategic Plan Working Group</i> Dr. Barbara A. Rapp	For significant contributions toward developing an NIH-wide Strategic Plan.
	<i>The Public Access Support Center Pilot Team</i> Renee E. Jellerette Stainback	For exceptional dedication, commitment, and creativity in developing and implementing the Public Access Support Center Pilot.

## AWARDS: OUTSIDE ORGANIZATIONS

A number of NLM staff were recognized by outside organizations for their outstanding efforts this year.

Award	Recipient	Accomplishment
<b>2016 Federal 100 Awards</b>	Dr. Sameer K. Antani	In recognition of his leadership in developing a system to automate the screening of digital chest X-rays for pulmonary abnormalities with a special focus on tuberculosis.
<b>2016 Herman Skolnik Award</b> <i>from American Chemical Society</i>	Dr. Evan E. Bolton Dr. Stephen H. Bryant	For their work in developing, maintaining, and expanding the National Center for Biotechnology Information's PubChem database of chemical substances and their biological activities.
<b>Outstanding Service Award</b> <i>from NIH Asian Pacific Islander American Organization</i>	Lucie S. Chen	For her dedication to the NIH Asian community, and for making outstanding contributions and demonstrated continual high-quality service to the NIH Asian Pacific American Community.
<b>Leveraging/ Collaboration Award</b> <i>from FDA Office of Surveillance and Biometrics, Center for Devices and Radiological Health</i>	<i>AccessGUDID Team</i> Ivor L. D'Souza Betsy L. Humphreys Chandra S. Kola Wei Ma Patrick L. McLaughlin <u>Contractors:</u> Joseph W. Schechter Joshua L. Temple	For exceptional and innovative collaboration between the FDA and NLM in launch of AccessGUDID, a public-facing portal for search and download of data from the Agency's Global Unique Device Identification Database (GUDID).



# Appendices





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**Appendix 1: Regional Medical Libraries and National Coordinating Offices****Regional Medical Libraries****MIDDLE ATLANTIC REGION**

University of Pittsburgh  
Health Sciences Library System  
States served: DE, NJ, NY, PA

**SOUTHEASTERN/ATLANTIC REGION**

University of Maryland at Baltimore  
Health Sciences and Human Services Library  
States served: AL, FL, GA, MD, MS, NC, SC,  
TN, VA, WV, DC, PR, VI

**GREATER MIDWEST REGION**

University of Iowa  
Hardin Library for the Health Sciences  
States served: IA, IL, IN, KY, MI, MN, ND, OH,  
SD, WI

**MIDCONTINENTAL REGION**

University of Utah  
Spencer S. Eccles Health Sciences Library  
States served: CO, KS, MO, NE, UT, WY

**SOUTH CENTRAL REGION**

University of North Texas Health Science Center  
Gibson D. Lewis Library  
States served: AR, LA, NM, OK, TX

**PACIFIC NORTHWEST REGION**

University of Washington  
Health Sciences Library  
States served: AK, ID, MT, OR, WA

**PACIFIC SOUTHWEST REGION**

University of California, Los Angeles  
Louise M. Darling Biomedical Library  
States served: AZ, CA, HI, NV, and US Territories in  
the Pacific Basin

**NEW ENGLAND REGION**

University of Massachusetts Medical School  
Lamar Soutter Library  
States served: CT, MA, ME, NH, RI, VT

**National Coordinating Offices****WEB SERVICES OFFICE**

University of Pittsburgh  
Health Sciences Library System

**DOCLINE COORDINATION OFFICE**

University of Maryland at Baltimore  
Health Sciences and Human Services Library

**TRAINING OFFICE**

University of Utah  
Spencer S. Eccles Health Sciences Library

**EVALUATION OFFICE**

University of Washington  
Health Sciences Library

**PUBLIC HEALTH COORDINATION OFFICE**

University of Massachusetts Medical School  
Lamar Soutter Library

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## Appendix 2: Board of Regents

The NLM Board of Regents meets three times a year to consider Library issues and to make recommendations to the Secretary of Health and Human Services affecting the Library.

### Chairperson

Greenes, Robert A., MD, PhD  
Professor & Ira A. Fulton Chair in Biomedical Informatics  
Arizona State University

### Members

Acquisti, Alessandro, PhD  
Professor  
Information Technology and Public Policy  
Heinz College  
Carnegie Mellon University

Martin, Sandra I., MSLS  
Director  
Shiffman Medical Library  
Wayne State University

Masys, Daniel R., MD  
Affiliate Professor  
Biomedical and Health Informatics  
University of Washington School of Medicine

Sternberg, Esther M., MD  
Research Director, Arizona Center for Integrative Medicine  
Director, Institute on Place & Well Being  
Professor of Medicine, The University of Arizona  
College of Medicine

Taylor, Jill, PhD  
Director  
Wadsworth Center  
New York Department of Health

### Ex-Officio Members

Clancy, Carolyn M., MD  
Deputy Undersecretary for Health for Organizational Excellence  
Veterans Health Administration

Ediger, Mark A., Lt Gen, USAF, MC  
Surgeon General  
United States Air Force

Faison, Forrest C., VADM  
Surgeon General of the Navy  
Chief, Bureau of Medicine and Surgery  
Department of the Navy

Hayden, Carla D., PhD  
Librarian of Congress  
Library of Congress

Murthy, Vivek H., VADM, MD, MBA  
Surgeon General  
Office of the Surgeon General, PHS  
Office of the Assistant Secretary for Health

Olds, James L., PhD  
Assistant Director for Biological Sciences  
National Science Foundation

Thomas, Richard W., MD, DDS, FACS  
President  
Uniformed Services University of the Health Sciences

West, Nadja Y., LTG  
Lieutenant General of the US Army  
The Surgeon General and Commanding General, US Army Medical Command  
Department of the Army

Wester, Paul, MLS  
Director  
National Agricultural Library  
U.S. Department of Agriculture

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### Appendix 3: Board of Scientific Counselors, Lister Hill National Center for Biomedical Communications

The Board of Scientific Counselors provides advice on NLM's intramural research and development programs for the Lister Hill National Center for Biomedical Communications.

#### Chairperson

Berner, Eta S., EdD  
Professor, Health Informatics  
Department of Health Services Administration  
School of Health Professions  
School of Medicine  
University of Alabama at Birmingham

#### Members

Cummins, Mollie R., PhD  
Associate Professor  
Schools of Nursing and Medicine  
University of Utah

Downs, Stephen M., PhD  
Professor and Vice Chair for  
General Pediatrics and Director for Children's Health  
Services Research  
Indiana University School of Medicine

Embi, Peter J., MD  
President/CEO, Regenstrief Institute, Inc.  
Sam Regenstrief Professor of Medicine  
Associate Dean for Information & Health  
Services Research  
IU School of Medicine  
Associate Director for Informatics, Indiana CTSI  
Vice President for Learning Health Systems,  
IU Health

Hripcsak, George M., MD  
Professor of Biomedical Informatics  
Columbia University Medical Center  
Columbia University

Johnson, Kevin B., MD  
Professor & Chair of Biomedical Informatics  
Professor of Pediatrics  
Chief Informatics Officer  
Vanderbilt University Medical Center

Murphy, Shawn N., MD, PhD  
Associate Professor of Neurology  
Harvard Medical School  
Department of Neurology  
Massachusetts General Hospital  
Partners Healthcare  
Research IS & Computing

Xu, Hua, PhD  
Professor  
School of Biomedical Informatics  
The University of Texas Health Science Center

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#### Appendix 4: Board of Scientific Counselors, National Center for Biotechnology Information

The Board of Scientific Counselors provides advice on NLM's intramural research and development programs for the National Center for Biotechnology Information.

##### Chairperson

De Crecy-Lagard, Valerie A., PhD  
Professor  
Department of Microbiology  
University of Florida

##### Members

Boehnke, Michael L., PhD  
Professor  
Department of Biostatistics  
School of Public Health  
University of Michigan

Edwards, Scott V., PhD  
Professor  
Department of Organismic and Evolutionary Biology  
Harvard University

Green, Rachel, PhD  
Professor  
Department of Molecular Biology and Genetics  
School of Medicine  
John Hopkins University

Guy, R. Kiplin, PhD  
Dean, College of Pharmacy  
University of Kentucky

Relman, David A., MD  
Professor  
Department of Microbiology and Immunology  
Stanford University

Wu, Chung-I, PhD  
Professor  
Department of Ecology and Evolution  
University of Chicago

Zhang, Jianzhi, PhD  
Marshall W. Nirenberg Collegiate Professor  
Department of Ecology and Evolutionary Biology  
University of Michigan

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#### Appendix 5: Biomedical Library and Informatics Review Committee

The Biomedical Library and Informatics Review Committee meets three times a year to review applications for grants under the Medical Library Assistance Act.

##### Chairperson

Sonnenberg, Frank A., MD  
Chief Medical Informatics Officer  
Professor of Medicine  
Rutgers Robert Wood Johnson Medical School

##### Members

Archer, Kellie J., PhD  
Professor and Chair  
Division of Biostatistics  
College of Public Health  
The Ohio State University

Bahar, Ivet, PhD  
Distinguished Professor and John K. Vries Chair  
Department of Computational & System Biology  
University of Pittsburgh

Bennett, Kristin P., PhD  
Associate Director  
Institute for Data Exploration and Applications  
Rensselaer Polytechnic Institute

Bernstam, Elmer V., MD  
Professor and Associate Dean for Research  
School of Biomedical Informatics  
Department of Internal Medicine, Medical School  
The University of Texas Health Science Center at  
Houston

Cimino, James J., MD  
Director  
Informatics Institute  
University of Alabama at Birmingham  
School of Medicine

Denny, Joshua C., MD  
Professor, Biomedical Informatics & Medicine  
Vice President for Personalized Medicine  
Department of Biomedical Informatics  
Vanderbilt University Medical Center

Elhadad, Noemie, PhD  
Associate Professor  
Department of Biomedical Informatics  
Columbia University

Gennari, John H., PhD  
Associate Professor  
Department of Biomedical Informatics and Medical  
Education  
University of Washington

Gollop, Claudia J., PhD  
Associate Professor  
School of Information and Library Science  
University of North Carolina, Chapel Hill

Holmes, John H., PhD  
Professor of Medical Informatics in Epidemiology  
Department of Biostatistics, Epidemiology, and  
Informatics  
Perelman School of Medicine at the University of  
Pennsylvania

Holmes, Kristi, PhD  
Director, Galter Health Sciences Library  
Associate Professor, Department of Preventive  
Medicine-Health and Biomedical Informatics  
Feinberg School of Medicine  
Northwestern University

Kann, Maricel G., PhD  
Associate Professor  
Department of Biological Sciences  
University of Maryland

Kho, Abel N., MD  
Assistant Professor  
Division of General Internal & Biomedical Informatics  
Northwestern University

Mooney, Sean D., PhD  
Professor, Biomedical Informatics & Medical  
Education  
Chief Research Information Officer  
University of Washington School of Medicine

Page Jr., C. David, PhD  
Professor  
Department of Biostatistics & Medical Informatics  
Department of Computer Sciences  
University of Wisconsin-Madison  
School of Medicine & Public Health

Rios, Gabriel R., MLIS  
Director  
Ruth Lilly Medical Library  
Indiana University School of Medicine

Shipman, Jean P., MSLS  
Health Sciences Librarian  
Executive Director, Knowledge Management &  
Spencer S. Eccles Health Sciences Library  
University of Utah

Szolovits, Peter, PhD  
Professor  
Computer Science and Artificial Intelligence Lab  
Massachusetts Institute of Technology

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## Appendix 6: Literature Selection Technical Review Committee

The Literature Selection Technical Review Committee advises the Library on matters of policy related to the evaluation and recommendations of biomedical publications to be considered for indexing and inclusion in MEDLINE.

### Chairperson

Nguyen, Thu Annelise, PhD  
Associate Professor  
Department of Diagnostic Medicine  
Kansas State University

### Members

Balasubramaniam, Sanjeeve, MD  
Medical Officer  
Office of Hematology Oncology Products  
Center for Drug Evaluation and Research  
Food and Drug Administration

Conte, Marisa L., BA  
Assistant Director, Research and Informatics  
Taubman Health Sciences Library  
University of Michigan

Corsi, Karen F., ScD  
Associate Professor  
Department of Psychiatry  
University of Colorado, Denver

Godoy-Vitorino, Filipa, PhD  
Research Professor  
Department of Natural Sciences  
College of Sciences and Technology  
Inter American University of Puerto Rico

Greenland, Kristen B., PhD  
Science Librarian  
Keefe Science Library  
Amherst College

Hodge, Felicia S., DRPH  
Professor and Director  
School of Nursing/School of Public Health  
Center for American Indian  
Indigenous Research and Education  
University of California, Los Angeles

Kalet, Adina, MD  
Associate Professor of Medicine and Surgery  
Section of Primary Care  
Division of General Internal Medicine  
New York University School of Medicine

Lemaire, Scott A., MD  
Professor of Surgery  
Division of Cardiothoracic Surgery  
Baylor College of Medicine

Nwomeh, Benedict C., MD  
Attending Surgeon, Professor  
Pediatric Surgery  
Nationwide Children's Hospital  
The Ohio State University

Yates, Bill J., PhD  
Professor  
Department of Otolaryngology and Neuroscience  
University of Pittsburgh

Yoshimura, Masami, DSc  
Associate Professor  
Department of Comparative Biomedical Sciences  
School of Veterinary Medicine  
Louisiana State University

Young, Karen M., PhD, VMD  
Clinical Professor of Clinical Pathology  
Department of Pathobiological Sciences  
School of Veterinary Medicine  
University of Wisconsin-Madison



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## Appendix 7: PubMed Central National Advisory Committee

The PubMed Central National Advisory Committee establishes criteria for groups submitting materials to the PubMed system, monitors its operation, and ensures that, as PubMed Central evolves, it remains responsive to the needs of researchers, publishers, librarians, and the general public.

### Acting Chairperson

Terry, Sharon F., MA  
President and CEO  
Genetic Alliance

### Members

Butter, Karen A., MLS  
University Librarian Emeritus  
Department of Administration  
University of California, San Francisco

Cantu, Adelita G., RN, PhD  
Associate Professor  
Family & Community Health Systems  
The University of Texas Health Science Center

Cooper, Nigel G.F., PhD  
Professor  
Department of Anatomical Sciences & Neurobiology  
University of Louisville

Dewey, Barbara, MA  
Dean  
University Libraries and Scholarly Communications  
Pennsylvania State University

Eisen, Jonathan A., PhD  
Departments of Medical Microbiology and  
Immunology  
UC Davis Genome Center  
University of California, Davis

Engelward, Bevin P., PhD, ScD  
Associate Professor  
Department of Biological Engineering  
Massachusetts Institute of Technology

Jongeneel, C. Victor, PhD  
Director  
High-Performance Biological Computing Group  
NCSA, Department of Bioengineering  
University of Illinois at Urbana-Champaign

Lively, Mark O., PhD  
Professor Emeritus of Biochemistry  
Director, Protein Analysis Core Laboratory  
Wake Forest University Institute of Regenerative  
Medicine  
Wake Forest Biotech Place

McCrary, Jr., Victor, PhD  
Vice President for Research and Economic  
Development  
Morgan State University

Morse, Randall H., PhD  
Research Scientist  
Molecular Genetics Program  
Wadsworth Center

Starratt, Jay, MA  
Dean of Libraries  
Washington State University

Stodden, Victoria, PhD  
Associate Professor  
Graduate School of Library and Information Science  
University of Illinois at Urbana-Champaign

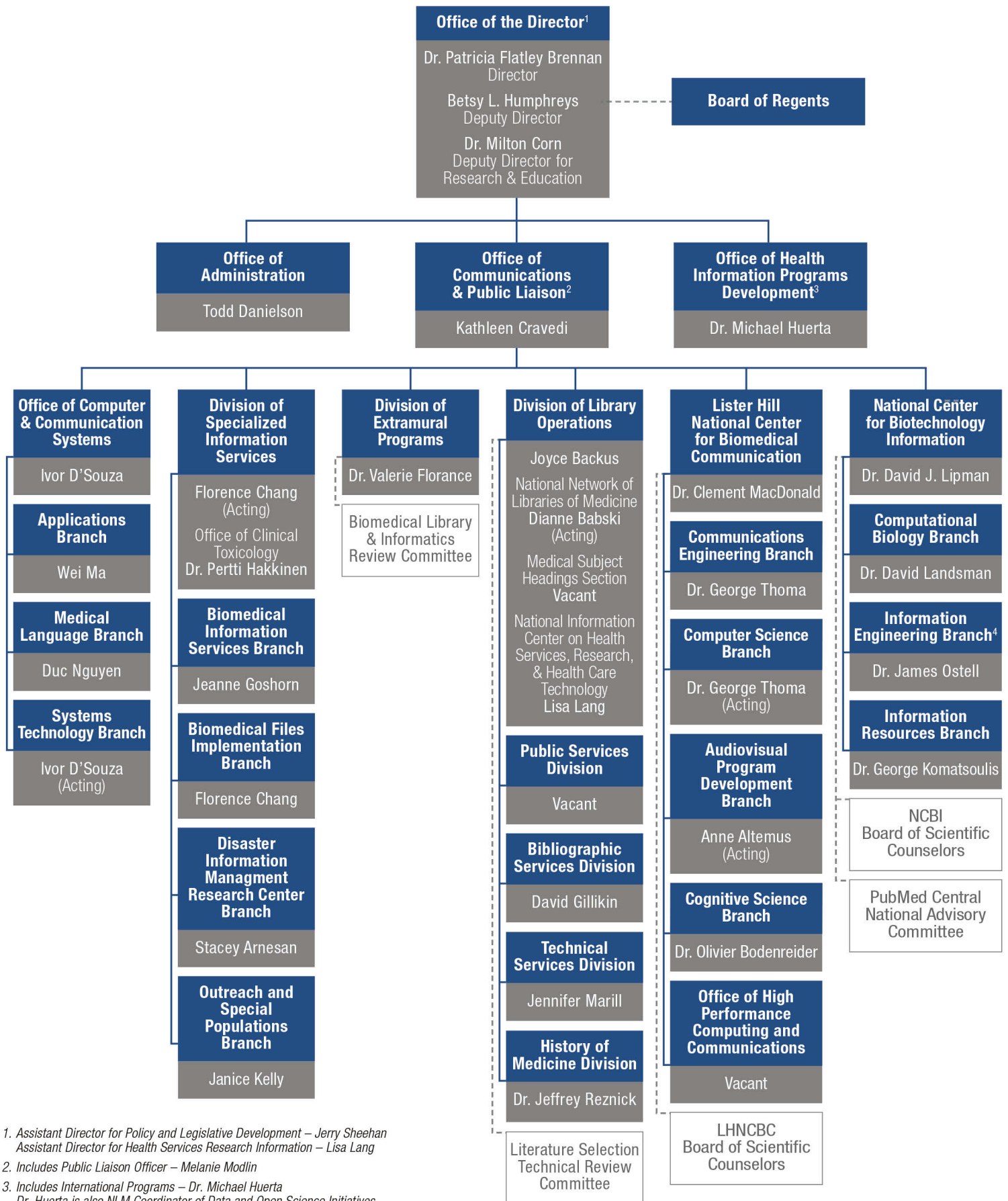
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For additional information regarding the  
programs described in this report, contact:

Office of Communications and Public Liaison  
National Library of Medicine  
8600 Rockville Pike  
Bethesda, MD 20894  
301-496-6308  
[publicinfo@nlm.nih.gov](mailto:publicinfo@nlm.nih.gov)  
[nlm.nih.gov](http://nlm.nih.gov)

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Cover:  
NIH Director Dr. Francis Collins administers the oath of office  
to the new NLM Director, Dr. Patricia Flatley Brennan, during  
her swearing-in ceremony Monday, September 12, 2016.  
(Design by Donald Bliss, Lister Hill National Center for  
Biomedical Communications, 2016.)

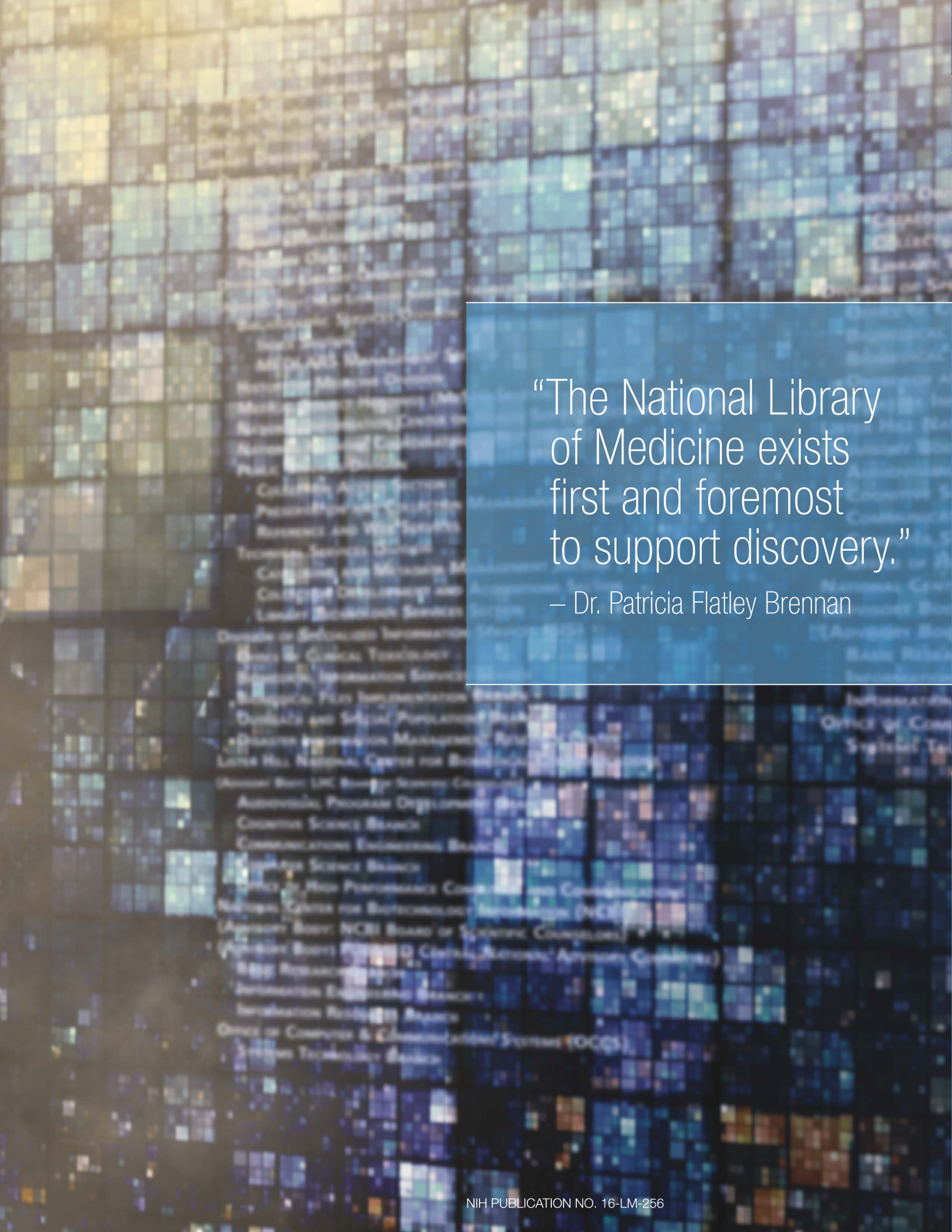


1. Assistant Director for Policy and Legislative Development – Jerry Sheehan  
Assistant Director for Health Services Research Information – Lisa Lang

2. Includes Public Liaison Officer – Melanie Modlin

3. Includes International Programs – Dr. Michael Huerta  
Dr. Huerta is also NLM Coordinator of Data and Open Science Initiatives.

4. Includes ClinicalTrials.gov – Dr. Deborah Zarin, Director



“The National Library  
of Medicine exists  
first and foremost  
to support discovery.”

– Dr. Patricia Flatley Brennan