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Articoli/*Articles*

FROM CARDS TO COMPUTERS: THE NATIONAL LIBRARY OF MEDICINE AND THE TRANSMISSION OF MEDICAL KNOWLEDGE

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SUMMARY

The National Library of Medicine (NLM) is the world's largest medical Library. Its collections total some 6 million items and NLM also sponsors a variety of key databases in the medical field. This article traces the history and the strategies of the Library from the origins until today.

The National Library of Medicine (NLM), on the campus of the National Institute's of Health in Bethesda, Maryland, is the world's largest medical Library. Its collections total some 6 million items - from books to manuscripts to audiovisual materials. NLM also sponsors a variety of key databases in the medical field, such as MEDLINE and TOXLINE. MEDLINE contains more than 12 million journal article references, and some 400 million searches of MEDLINE are done via the worldwide web each year. The Library's Lister Hill National Center for Biomedical Communications carries out research and development in the field of medical communications and medical informatics, and its National Center for Biotechnology Information distributes Gen Bank, a collection of all known DNA sequences, and also provides access to the assembled Human Genome data. The extramural program of the Library provides grant support in areas such as medical informatics and history of medicine.

Key words: National Library of Medicine - Bethesda - Transmission of Medical knowledge

Yet this eminent and important center for biomedical information began as a small collection of books on the shelf of the Surgeon General of the United States Army in the first half of the nineteenth century. James Lovell was the first Surgeon General appointed after the creation of the modern Medical Department of the Army in 1818. Soon after his appointment, Lovell began to purchase various medical books and journals for distribution to medical officers around the country. But he also bought some items for use in his own office, and this collection eventually grew into a library. The birth of the Surgeon General's Library, which was later to become the National Library of Medicine, is generally considered to be 1836, for it was in that year that one first finds a separate line item in the budget for books for the Surgeon General's Library, a modest sum of $150.

The first known catalog of the Library is a manuscript dated 1840. It lists 134 titles, comprising some 200 volumes. The entire collection, smaller than the private libraries of many physicians of the period, could have fit into a single four-shelf bookcase eight feet in width. By comparison, the library of the Pennsylvania Hospital at that time consisted of about 5,000 volumes.

The Library of the Surgeon General's Office continued to remain small and insignificant until it came under the direction of John Shaw Billings in 1865. Billings was an Army surgeon who served in the Civil War. At the end of 1864, he was assigned to duty in the Office of the Surgeon General. At the time, that office and its small library were housed in a two-story building located at Pennsylvania Avenue and 15th Street, N.W, near the White House. In 1865, Surgeon General Joseph Barnes decided to place Billings in charge of the growing collection of books and journals. He could not have made a better choice.

When Billings took charge, the Library consisted of some 1,800 volumes. By the time he left the Library in 1895, after thirty years, the collection had grown to about 73,000 books, 39,000 journal volumes, and over 200,000 individual pamphlets and theses, making it the largest medical Library in the world.

Billings waged an intensive campaign to build the collection through purchases, gifts, and exchanges. He published want lists, asked Army surgeons in the field to encourage physicians to do-

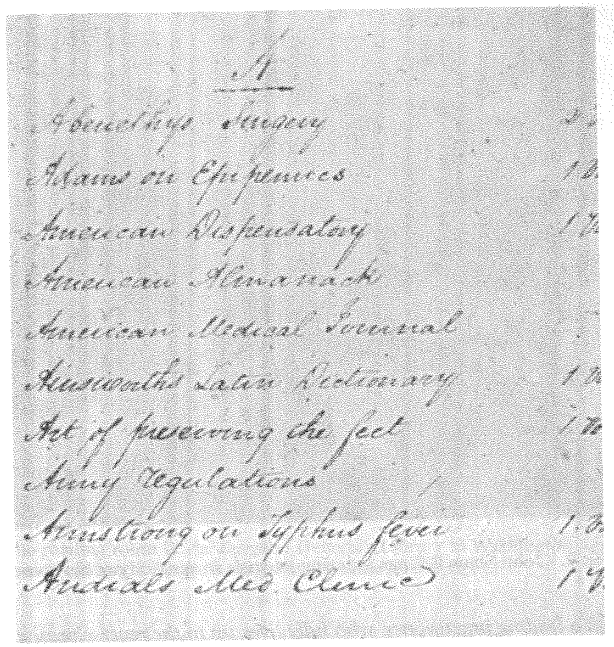
A
Armstrong on Typhus fever

Fig. 1. - A page from the first catalog (1840) of the Library of the Office of the Army Surgeon General, forerunner of the National Library of Medicine. (All photographs courtesy of the National Library of Medicine).

nate materials to the Library, wrote to U.S. consuls abroad to obtain foreign publications, and did whatever else he could to acquire materials for the Library. One surgeon from Maine wrote to Billings about his efforts to obtain copies of the *Maine Medical and Surgical Reporter* for the Library from a local physician:

> *Dr. Gilman, one of the old practitioners here, has repeatedly promised to let me have them, he says he knows he has them stored away with other med. Literature in his garret, and will certainly hunt them up. Now Dr. Gilman is one of these easy going old gentlemen rather fond of his alcohol,*

Fig. 2. - John Shaw Billings indexing journals in the study of his home.

though a leading practitioner, who fully lives up to the reverse principle of never doing today what can possibly be deferred until tomorrow, or next week preferably. Simply I can not get him to look them up; but will suggest to him the propriety and desirability of doing so at suitable intervals.

After not getting anywhere with Dr. Gilman for two months, the surgeon took his case to Mrs. Gilman. She located the volumes in question. Billings himself could be very persuasive in convincing people to donate materials to the Library, as is attested to by this quotation from Oliver Wendell Holmes:

Dr. Billings is a bibliophile of such great eminence that I regard him as a positive danger to the owner of a library, if he ever be let loose in it.

I should note that Billings' collecting included historical as well as contemporary materials. He added rare books, manuscripts, and art prints to the collection, thus initiating the Li-

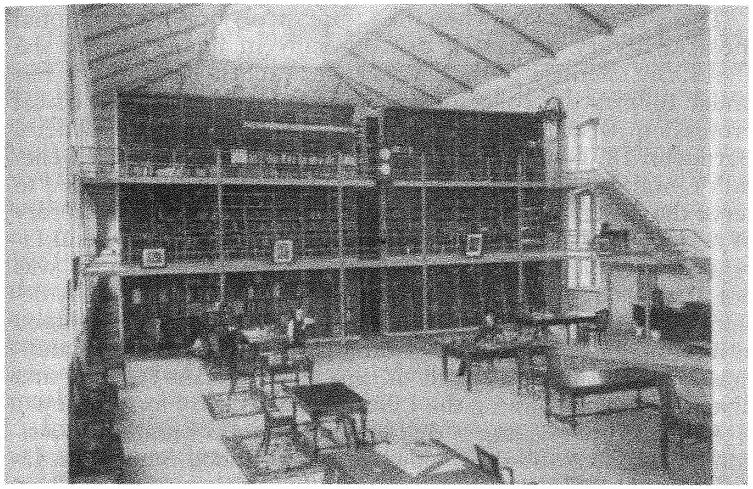

Fig. 3. - The reading room of the Surgeon General's Library in Washington, D.C. in the late nineteenth century. Billings is seated at the table on the right.

brary's important historical component. When he took over the Library, it contained no book published before 1700 and only seven 18th-century titles. By 1868, just three years after he took charge, the Library owned well over 200 pre-1800 works. During his tenure, the Library obtained its copies of many classic works, such as Vesalius on anatomy and Withering on the foxglove, at a time when such works were more available and affordable than they are today. For example, in 1883, Billings purchased a 1668 work by Thomas Sydenham, which the book dealer described as very rare, for about sixty cents.

Shortly after Billings came to the Library, it moved to new quarters in Ford's Theater. The theater was of course the site of Lincoln's assassination in 1865, and after that tragedy the public objected vehemently against further performances at the theater. So the federal government purchased the building. The theater was remodeled and occupied by several units of the Surgeon General's Office, including the Library, in 1867.

This was the period when the Library truly became a national medical library, in fact if not officially in name. Before the 1860s, the clientele of the Library was exclusively military, but under Billings the collection was opened to the entire medical profession. Discussions between Billings and Surgeon General Barnes in 1871 broadened the objectives of the Surgeon General's Library to make it a "national medical library," designed to serve the American medical community as a "universal Library of reference." Billings even used the term "National Medical Library" on certain forms and other documents, although it was not until 1956, as we shall see, that the Library was officially designated as the National Library of Medicine. Although designed as a reference rather than a lending Library, books were sometimes loaned for short periods of time to physicians residing at a distance, thus beginning the Library's interlibrary loan policy.

Although the building of this large reference collection was a significant contribution to medicine in the United States, the Library under Billings also undertook other projects that were exceedingly influential in the transmission of medical knowledge. Chief among these was the cataloging and indexing of the medical literature. In the early 1870s, Billings decided to undertake the monumental task of preparing a subject catalog and index to the literature in the Library. Not only would he include books and pamphlets, but he would also index substantive articles in periodicals.

He began the task of indexing journal articles on New Year's Day, 1874. Billings would scan the journals and check the title of each article that he wanted indexed. His clerks would then copy on a card the complete reference to the article, leaving the top blank for Billings to add a subject heading. Billings reviewed journals in his office and at home. Every day a government van would leave a wagon load of journals at his residence in Georgetown for him to go through that evening. One visitor to his home recalled Billings "resting" after a day's work:

> *He was lying on a couch, almost hidden by two mountains of medical periodicals in every language, one on either side of him. He was slowly, but without pause, steadily working through the mountain on his right, marking the items to be indexed, and transferring each journal, as he finished, to the mountain on his left.*

The result of this indexing effort was the creation of the Library's serially-published *Index-Catalogue*, the first volume of the first series of which appeared in 1880. It retrospectively indexed the most important periodical literature in the Library, as well as books, pamphlets, and dissertations, providing a remarkable subject index to the Library's holdings (as well as an author index to the monographs). Future series of the *Index-Catalogue* continued the indexing of the Library collection up to 1961 (although in later series journal articles were no longer indexed in the *Catalogue*, this task being left to *Index Medicus*). Incidentally, the Library has just completed a project to make the contents of *Index-Catalogue* available in a searchable form online on the web, and this will provide medical historians with a remarkable resource.

In addition to indexing the Library's collection retrospectively, however, there was also a need for an index to the current medical literature (especially the journals) in medicine. This need led to the creation of the monthly publication *Index Medicus*, published by Frederick Leypoldt of New York, who also served as the publisher of the *American Library Journal*, and edited by Billings and his coworker Robert Fletcher. The first volume of *Index Medicus*, which provided a subject index to the current medical current periodical literature in medicine, appeared in 1879, and it has continued to be published to this day. Eventually, the Library took over the publication of *Index Medicus*. The Library's MEDLINE database, as we shall see, evolved out of this publication. William Welch, writing in 1913, called the publication of *Index-Catalogue* and *Index Medicus* "probably the most original and distinctive contribution of America to the medicine of the world."

Due to Billings' success at collecting, the Library soon began to outgrow Ford's Theater. Billings was also concerned about the building because it was not fireproof and was not designed to hold the heavy weight of books and files that it housed at the time. In 1880, he began to campaign for a new building for the Surgeon General's Library and Museum. Eventually he was successful, and a quarter of a million dollars was appropriated for

the construction of a building on the national mall (in the location where the Hirshhorn Museum stands today). In 1887, the Surgeon General's Library and Museum moved into the new building. A few years after the Library vacated Ford's Theater, the interior of that building did collapse during a renovation, killing 22 people. The building on the mall was to remain the Library's home for the next 75 years.

Billings had worked closely with the architect for the purpose of designing a building specifically for the purpose of housing a library and museum. The large Library Hall, equipped with book stacks, desks and chairs, had no artificial illumination, but the many large windows and a skylight provided sufficient light for reading, except on very overcast days. Later the hall was wired for electricity, although inadequately. After flashlights were invented, they were frequently used by those paging books to help locate titles in the dimly lit stacks. Library Hall also proved difficult to heat on extremely cold days. Despite these inconveniences, however, the Library had much more space and far better conditions than it had ever had before.

Some of the rules of the Library in the 1890s strike us as amusing today. For example, spitting on the floor was prohibited, but spittoons were provided for this purpose. Smoking was permitted in the Library, but the staff objected to the leaving of smoldering cigars or cigarettes on tables instead of in the ashtray.

Billings left the Library in 1895, and became the first Director of the newly created New York Public Library. Over the next forty years, there were a total of eleven different Directors of the Surgeon General's Library, only two of whom served for an extensive period of time. During the Depression, the Library fell on hard times along with the rest of the country. Almost all of its declining acquisitions budget was set aside for journals, and during one two-year period only 16 books were purchased. In time, the building also began to deteriorate, especially since there were not always adequate funds for upkeep. Even with the decreased rate of acquisition, the Library was becoming overcrowded.

When the United States entered the Second World War in 1941, there was a fear that Washington might be bombed, and a

number of institutions took steps to protect their cultural treasures. The Director of the Surgeon General's Library, which was by then called the Army Medical Library, ordered all of the Library's rare books and manuscripts to be gathered together and moved to a safe place. Arrangements were made with the Allen Memorial Medical Library in Cleveland, which was thought to be safe from enemy air attack, to have these materials moved there for the duration of the war. Some 20,000 items were sent to Cleveland in 1942. A staff was hired to administer the historical collections in Cleveland, marking the beginning of the Library's History of Medicine Division. When the war ended, the Library on the mall was too overcrowded to take the historical collections back, and so they remained in Cleveland until 1962 when the Library moved to a new building.

A report on the state of the Army Medical Library published in 1944 made a number of recommendations for major changes, including pointing out the necessity of a new building for the Library. An even more dramatic change was proposed by a commission in 1955, which recommended that the Library be transferred from the Armed Forces to the Public Health Service and be renamed the National Library of Medicine (NLM). This plan was adopted, and in 1956 the National Library of Medicine came into being. A site on the grounds of the National Institutes of Health in Bethesda, Maryland was selected for a new Library building, which was fully occupied in 1962. In addition to moving the collection from the mall to Bethesda, the Library also reclaimed the historical materials from the Allen Library in Cleveland. The historical collections were shipped to Bethesda in four vans, each guarded by a Pinkerton detective, and insured in transit for $6 million by Lloyd's of London.

Frank Bradway Rogers had become the Director of the Library in 1949, and he guided it through this change in administrative and physical home. Under his leadership, the Library also began to make improvements in acquisitions, cataloging, and other areas. Perhaps the most important contribution during Rogers' tenure, however, was the development of MEDLARS, an acronym for medical literature retrieval and analysis system. MEDLARS represented the beginning of the computer era at

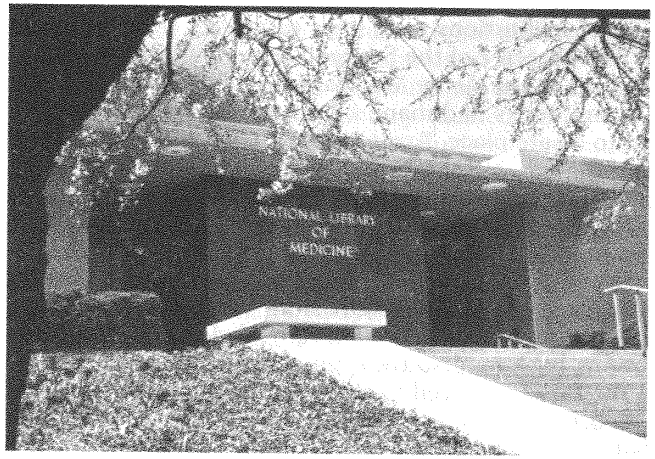

Fig. 4. - Entrance to the National Library of Medicine in Bethesda, Maryland.

NLM. MEDLARS was a computerized system for handling the articles indexed by the Library's staff. The system produced photographic masters for printing *Index Medicus* and other publications. In addition to providing the copy for the printing NLM publications, MEDLARS also allowed for computer searches of the databases, but at first patrons could not access and search the system directly. Written search queries were sent to the Library where batch searches were conducted by staff and printouts of the retrieved citations were mailed to the patrons.

Soon after the creation of a research and development program at the Library in 1967, a subject which will be discussed below, facilities were set up for experimenting with computer online retrieval systems. Research staff developed a practical online bibliographic system which used the citations in *Abridged Index Medicus*, which was (as the title indicates) an abridged version of *Index Medicus*, as the basis of a database. In 1970, this retrieval system was opened to a select group of users across the country. These users were enthusiastic about speed with which

they were able to obtain bibliographic information by direct search of the system. The search service was rapidly expanded and evolved into MEDLINE, from MEDLARS onLINE. MEDLINE permitted researchers, educators, librarians, and medical practitioners to community directly with MEDLARS. MEDLINE was the first of several online databases to be developed and/or made available by the National Library of Medicine. Examples of these databases include TOXNET, actually a set of databases in toxicology and environmental health, and DIRLINE, an online directory of health organizations. Most of them are now accessible over the internet at no charge. At the present time, there are on average over a million searches a day on MEDLINE alone via the internet.

As previously mentioned, NLM initiated a systematic program of research and development in 1967. Martin Cummings, the Director of the Library at the time, believed that libraries of the future would have to concern themselves with rapid communication such as radio, television, and computers, and that research ought to be carried out to test new networks for communicating biomedical information and to evaluate new technologies such as computer software for information retrieval. Cummings received the Congressional support he needed when the House Committee on Appropriations encouraged the Library to become a center for research and development in biomedical communications and appropriated funds for this purpose in the fiscal year 1967 budget. The Library received $118,000 and four new positions to support this new research and development program. Ruth Davis was hired from the Department of Defense in 1967 as the Library's Associate Director of Research and Development. When Senator Lister Hill retired in 1968, Congress designated the Library's research and development program as the Lister Hill National Center for Biomedical Communications. On August 3, 1968, President Lyndon B. Johnson signed Public Law 90-456 which authorized the Center. Secretary of Health, Education, and Welfare Wilbur Cohen stated:

> *This Center honors Senator Lister Hill of Alabama for his distinguished contributions to improved health for the American people. It will serve as*

the delegated agent for the Department in the development and coordination of networks and information systems to improve health education, medical research, and the delivery of health services.

Soon after the establishment of the Lister Hill Center, NLM Director Cummings began requesting funds for a new building to house the Center.

Finally, in 1976, Congress approved the necessary funds and construction began. The building was ready for occupancy in May, 1980. The building was dedicated on May 22, with now retired Senator Lister Hill in attendance.

Over the years, the Lister Hill Center has made many contributions to research in the field of biomedical communications. For example, the Lister Hill Center has played a pioneering role in the area of satellite applications in medicine. Beginning in 1970, the Center, utilizing a satellite of the National Aeronautics and Space Administration (NASA), worked with the Indian Health Service and the Alaska Native Medical Service to establish an essentially interference-free voice communications network between physicians at the Alaska Native Medical Center and health aides in 26 native villages. This project provided a reliable system of physician consultation at a distance. In the late 1970s, the Center designed, developed, and managed a teleconferencing system using NASA's Communications Technology Satellite. This system permitted two-way audio and video communication between Bethesda and various other sites. It was used to provide access to conferences and educational programs by telecommunication.

Space does not permit me to describe all of the current activities of the National Library of Medicine and its Lister Hill Center in the field of biomedical communications, and this would take us beyond the realm of history in any case. Suffice it to say that NLM, under its current Director, Donald Lindberg, is doing innovative work in such areas as artificial intelligence, medical imaging, and telemedicine. I refer the reader to the Library's website, www.nlm.nih.gov, for further information on the Library's programs. I would like to close by quoting the words of Octo Barnett, Professor of Medicine at Harvard University, from the paper he delivered at the Library's sesquicentennial symposium in 1987 (the proceedings of which were published as *Past, Present and Future of Biomedical Information*). Barnett had the following to say about NLM:

The NLM had been a pioneer in promoting easy and inexpensive access to the published literature. The advances made possible in bibliographic retrieval by NLM have impacted more members of the health care community than any other single application of information technology...The NLM has been one of the most important institutions in making information available to the health science professional...The NLM has had an admirable role in the past in facilitating the storage and dissemination of medical knowledge. In the future, the role of NLM can be even more important in supporting the application of the full range of information technology to the education of the student in health sciences and to the support of the practicing health professional.

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