

Conversations with Medical Informatics Pioneers:
An Oral History Collection

At the Helm of the World's Largest Biomedical Library

2005 Interviews of Donald A.B. Lindberg

Interviewers:

Joan S. Ash & Dean F. Sittig

Editors:

Rebecca M. Goodwin, Joan S. Ash & Dean F. Sittig



U.S. National Library of Medicine

At the Helm of the World's Largest Biomedical Library

2005 Interviews of Donald A.B. Lindberg

Conversations with
Medical Informatics Pioneers:
An Oral History Collection

Interviewers:

Joan S. Ash & Dean F. Sittig

Editors:

Rebecca M. Goodwin, Joan S. Ash & Dean F. Sittig

Published by the U.S. National Library of Medicine, March 26, 2015; updated September 4, 2015.

Copyright Information

Government information at NLM Web sites is in the public domain. Public domain information may be freely distributed and copied, but it is requested that in any subsequent use the National Library of Medicine (NLM) be given appropriate acknowledgement.

Suggested citation:

Lindberg DAB. "At the helm of the world's largest biomedical library," Conversations with Medical Informatics Pioneers: An oral history collection. Ash JS, Sittig DF, interviewers. Goodwin RM, Ash JS, Sittig DF, editors. Bethesda: U.S. National Library of Medicine (NLM); 2015. Available from: <http://lhncbc.nlm.nih.gov/project/medical-informatics-pioneers>.

Photographs:

When using NLM Web sites, you may encounter documents, illustrations, photographs, or other information resources contributed or licensed by private individuals, companies, or organizations that may be protected by U.S. and foreign copyright laws. Transmission or reproduction of protected items beyond that allowed by fair use as defined in the copyright laws requires the written permission of the copyright owners. Specific NLM Web sites containing protected information provide additional notification of conditions associated with its use.

Content distributed via the NLM Conversations with Medical Informatics Pioneers Oral History Project may be subject to additional license and use restrictions applied by the depositor.

Oral History Interviews with Donald A.B. Lindberg

Editors: Rebecca M. Goodwin, Joan S. Ash, and Dean F. Sittig

Interviewers: Joan S. Ash and Dean F. Sittig

Managing Editor: Rebecca M. Goodwin

Copy Editing: Cindy Allen and Marie Gallagher

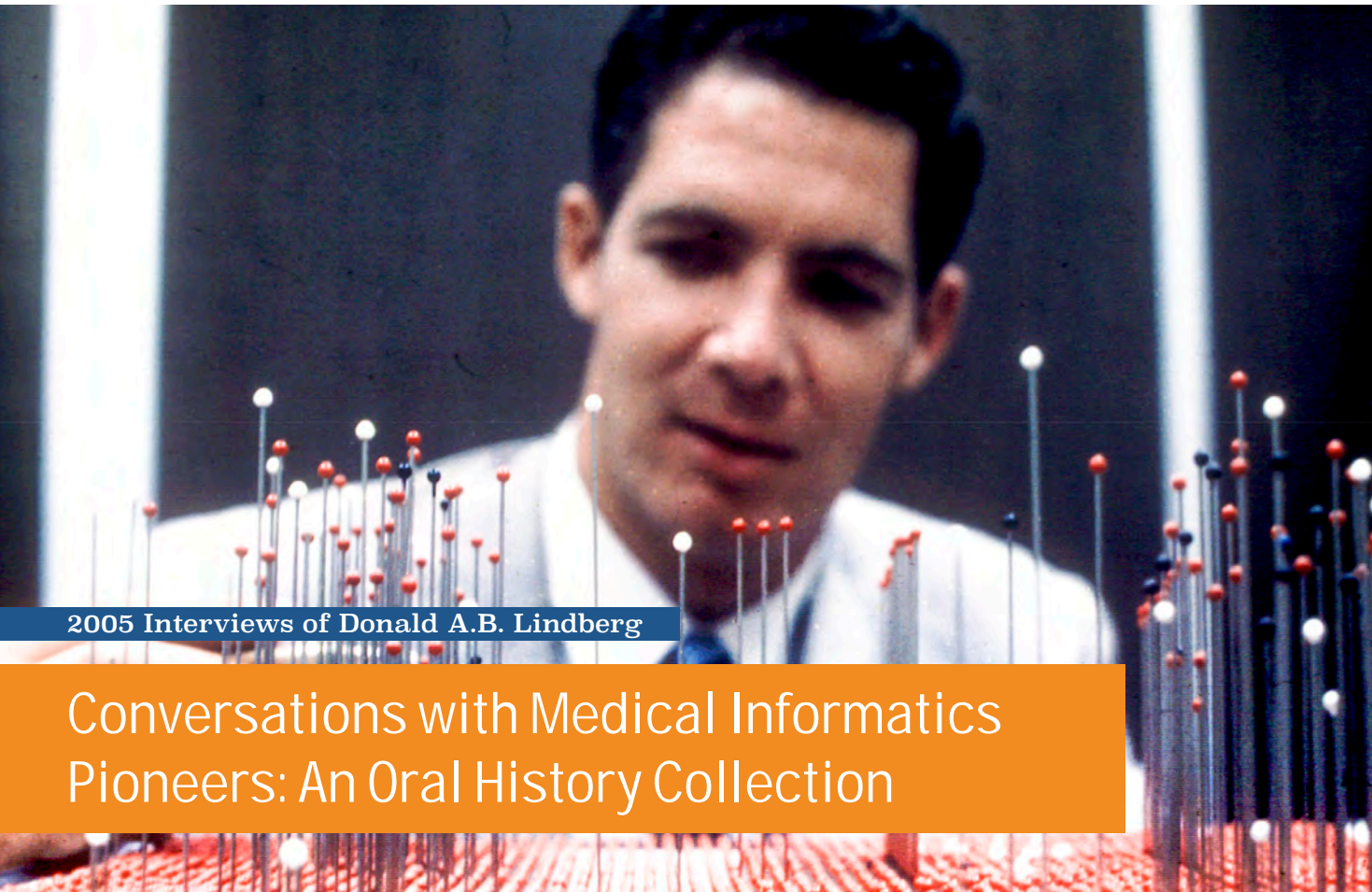
Design & Layout: Troy Hill, Bona Kim, John Harrington and Anne Altemus

Photo Editing: Troy Hill and Sandy Triolo

Photo & Captions: Kathy Cravedi, Pat Carson, Fran Sandridge, Betsy Humphreys, Don Detmer, Marie Gallagher and Patti Brennan.

Deeds of Gift: Rebecca Warlow, John Rees and Jeff Reznick

Contact: www.nlm@nlm.nih.gov



Personal collection of Donald A.B. and Mary M. Lindberg.

2005 Interviews of Donald A.B. Lindberg

Conversations with Medical Informatics Pioneers: An Oral History Collection

Don Lindberg in the laboratory, ca. 1950s.

At the Helm of the World's Largest Biomedical Library

Dr. Donald A.B. Lindberg, an eminent pathologist, served as Director of the National Library of Medicine for more than 30 years and has made important contributions to information and computer activities in medical diagnosis, artificial intelligence, and educational programs.

INTERVIEWED BY
JOAN ASH AND DEAN SITTIG

JUNE 1, 2005
WOODS HOLE, MA
& JULY 13, 2005
BETHESDA, MD

Donald A.B. Lindberg, MD, pioneered the application of computer technology to healthcare,^{1,2} beginning in 1960 as a Professor of Information Science and Professor of Pathology at the University of Missouri–Columbia.³ In 1984, Dr. Lindberg was appointed as Director of the National Library of Medicine, the world's largest biomedical library,⁴⁻⁷ and served as NLM Director until he retired in 2015.^{8,9}

From 1992 to 1995, he served in a concurrent position as Founding Director of the National Coordination Office for High Performance Computing and Communications (HPCC)¹⁰⁻¹³ in the Office of Science and Technology Policy, Executive Office of the President. In 1996, the HHS Secretary appointed him to serve as the U.S. Coordinator for the G-7 Global Health Applications Project.¹⁴ He is a leader in the Federal Networking and Information Technology Research and Development (NITRD) initiative to improve health and health care.

Dr. Lindberg was elected the first President of the American Medical Informatics Association (AMIA). He is also a founding member of the Health on

the Net Foundation, an international organization devoted to guiding patients and providers to sound, reliable health information.¹⁵⁻²⁸ As the country's senior statesman for medicine and computers,^{5,29-33} he has been called upon to serve on many boards including the Computer Science and Engineering Board of the National Academy of Sciences, the National Board of Medical Examiners, and the Council of the Institute of Medicine of the National Academy of Sciences.

Dr. Lindberg is the author of three books: *The Computer and Medical Care*;²⁹ *Computers in Life Science Research*;³⁴ and *The Growth of Medical Information Systems in the United States*,³⁵ several book chapters, and more than 200 articles and reports. He has served as editor and editorial board member of nine publications including the *Journal of the American Medical Association*.

Dr. Lindberg graduated *Magna cum Laude* from Amherst College and received his MD degree from the College of Physicians and Surgeons, Columbia University.³⁶ He received honorary doctorates from Amherst College, the State University of New York at Syracuse, the University of Missouri-Columbia, University for Health Sciences, Medical Informatics and Technology, Innsbruck, Austria, and Old Dominion University. In 2004, he became the

namesake of Vanderbilt University Medical Center's Donald A.B. and Mary M. Lindberg University Professor of Biomedical Informatics.³⁷ Dr. Lindberg and his wife Mary raised three sons – Don Jr., Chris, and Jon. They are also the proud grandparents of Martin and Frances.

Dr. Lindberg has received numerous honors including Phi Beta Kappa, Simpson Fellow of Amherst College, Markle Scholar in Academic Medicine, Surgeons General's Medallions, the First AMA Nathan Davis Award for outstanding Member of the Executive Branch in Career Public Service, the Walter C. Alvarez Memorial Award of the American Medical Writers Association, the Presidential Senior Executive Rank Award, Founding Fellow of the American Institute of Medical and Biological Engineering, the Outstanding Service Medal of the Uniformed Services University of the Health Sciences, Federal Computer Week's Federal 100 Award, Computers in Healthcare Pioneer Award, Association of Minority Health Professions Schools Commendation, RCI High Performance Computing Industry Recognition Award, U.S. National Commission on Libraries and Information Science Silver Award, Council of Biology Editors Meritorious Award, Presidential Rank Award of Meritorious Executive in the Senior Executive Service, Medical



Personal collection of Donald A.B. and Mary M. Lindberg.



Personal collection of Donald A.B. and Mary M. Lindberg.

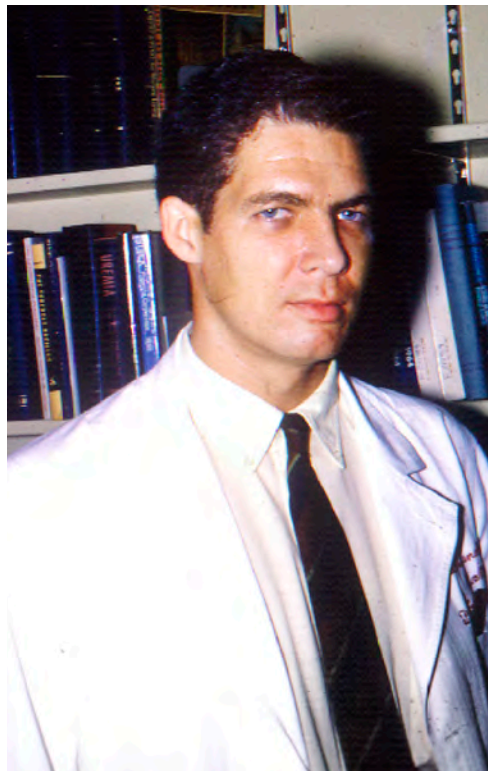
Painted by Donald A.B. Lindberg while a high school student at Polytechnic Preparatory Country Day School, in Dyker Heights, Park Slope, Brooklyn, NY, ca. 1949.

Library Association President's Award, American College of Medical Informatics Morris F. Collen, M.D. Award of Excellence,³⁸ Johns Hopkins University School of Medicine Ranice W. Crosby Distinguished Achievement Award, New York Academy of Medicine Information Frontier Award, Cosmos Club Award, American Medical Women's Association Lila A. Wallis Women's Health Award, U.S. Medicine Frank Brown Berry Prize, University of North Carolina Louis Round Wilson Academy Prize for Lifetime Achievement, NFAIS Miles Conrad Award, Research!America Geoffrey Beene Builders of Science Award,³⁹ and the CNI Paul Evan Peters Award, and Fellow of the American Association for the Advancement of Science, the New York Academy of Medicine, the American Academy of Arts and Sciences.

JA *It's June 1, 2005, and this is Joan Ash interviewing Dr. Don Lindberg in the Archives, Rare Book Room, at the MBL [Marine Biological Laboratory] in Woods Hole. I thought we could divide this up into the biographical piece, pre-NLM, and then NLM, and then about the profession. My first question is, where were you born and raised, and could you tell us something about your earlier education at Amherst and then through medical school?*

DL Sure. Gladly. I'm glad you didn't say "raised and grew up," because some people deny they've ever grown up. But in any case, I was born and brought up in Brooklyn, New York. I spent the summers, usually, in Nova Scotia, but the rest of the year in Brooklyn. I rather enjoyed it. I probably got more education before Amherst than after it, because I went to a very, very good prep school, Polytechnic Preparatory Country Day School, on Dycker Heights. I always say—bar none—those were the most important four years of

I fell in love with biology.



Dr. Donald A.B. Lindberg wearing his lab coat, ca. 1958.

education for me. Even though Amherst was a swell college, and P and S [Columbia University College of Physicians and Surgeons] was a swell medical school, for me, the prep school was much, much more important.

JA *Well, as far as medical school goes, how did you end up in medical school?*

DL Well, I fell in love with biology. At first, I was an English major at Amherst, but then I encountered Oscar Schotté⁴⁰ and experimental embryology and took that up with great pleasure—marvelous teacher. And so I was headed—at least I was launched—in the direction of a career in biology. Amherst had an honors program in those days, so the third and fourth years were really very, very much devoted to lab experimentation.

We had our own labs, we had our own animals, we had our own histologists—although I could do histology. We really were doing experiments, and those are reported in FASEB [Federation of American Societies for Experimental Biology] and so forth and in other publications.⁴¹ But the intent was that a person, having completed four years of a nominally liberal arts education at Amherst, be able to say, "Okay [raps table for emphasis], I am a biologist," and then maybe go do something else, or do biology. But to have the feeling that I am now a biologist. And of course there was some competition to get in the programs, but it was very, very well worthwhile.

On the other hand, there was always the gnawing question of, well, what about medicine? So I finally decided that I would probably feel regretful if I didn't do the medical school, having the feeling of, well, what the heck? That's sort of study of human biology, anyway. And then I could always go either direction I wished. That, of course, proved to be quite naïve, because even a good medical school

Personal collection of Donald A.B. and Mary M. Lindberg.

like P and S is very, very far from being the study of human biology. I mean, it's a high-class trade school, at best. So Schotté, this good chief, told me, "Well, here's the Rockefeller Institute. Go there. I'll get you in, in their doctoral program." So I essentially went through medical school—at least the first year—on a month-by-month contract with myself. Namely, if this doesn't get better by the first of next month, by God, I'm going to get on the subway and go down to Rockefeller and plead for admission.

My medical school experience was a sweet and sour thing. It's thrilling, and it's tedious, in alternating combinations. It's a sort of a grind that's committed to large amounts of memory work, which is really almost antithetical to experimental science. But, it has its appeal. Every once in a while you get to see some patients. And every once in a while you get to visit them in their homes or apartments. After a while, you finally can get to do a little physical diagnosis. So the month-to-month, I never quite pulled the trigger on myself and went to Rockefeller. I got through the year, feeling that I *could* have. And then at the end of the first year, I went back to Amherst for another summer. We completed some experiments that I had in mind to do there with Dr. Schotté. So that was that part of it.

JA *But then why pathology?*

DL Well, that was very straightforward. I mean, in the end, I decided that pathology actually had answers. I had fallen completely in love with every single medical specialty we encountered, as they say, *ad seriatim* [one after another]. I mean, once I decided that I was going to stay in the med school, I loved it. And, of course, once you get through the first two years, the clinical years are very, very different from the first two. So I thought I was the world's—God's—gift to internal medicine, and to general surgery, and to obstetrics, and to psychiatry, *ad seriatim*. Peds [pediatrics] I liked—I actually did a substitute residency in peds, but pediatric oncology was more than I could bear. But everything else I could have happily done. But I thought, "Hey, I've had more answers [with pathology]." So I went into path. Actually, I was

offered, by Robert Loeb, an internship in internal medicine at P and S. And that was, in their view, of course, the top mark. I didn't tell them that I actually was loving surgery. [chuckles] Internists don't think you should ever enjoy surgery, but I did.

So path was swell, path was a lot of fun. Some questions did have answers. Actually, to me, the major challenge that path offered was, could I think again? Because after medical school, you really, even with the best school in the world, have become a kind of a learning automaton, in a certain sense. So I can remember

vividly, by the spring of the senior year, which was getting mighty close to when they're really calling you "Doctor," sitting in this two-story amphitheater at P and S—the old-style, you know. But in the pit of those amphitheaters were the most distinguished medical people in the world. I mean, I must say that was a tremendous advantage of P and S. Anyway, here was a visiting professor or something—I think in this case, from Italy, with very, very good English, of course—a distinguished clinician, investigator, and lecturer, and so forth. But he, strangely enough, for an academic, he finished his lecture a little early, and there were 10 or

15 minutes left for questions.

I realized that four years ago, at Amherst, I would have had a dozen questions, and I would have had three experiments on my mind to do to figure them out. And after four years

of medical school, I was sitting there like a dummy with a sharpened pencil in my hand, ready to write down some more. So I gave myself a little mental challenge. I said, "Okay, you can accept this offer to be in pathology at P and S, an academic place, but you've got to get your head going again. You've got to have some kind of an original thought in the first year, or else—. Frankly, what I told myself is, "You're going to go to Mayo Clinic in clinical path." Now, that, of course, is a wonderful place, but it was not a researching place, it was not P and S. So I was still thinking I probably liked path, but if you can't think, you can't be an academic.

While liking the work, the first six months, I suppose, must have been a stress for me, because it's the only time in my whole life I've ever had ulcer symptoms. About six months through the first

I decided that pathology actually had answers.

If you can't think, you can't be an academic.

year of path, I had been working with the deaths, of course, at Presbyterian Hospital. And the deaths were very numerous from open-heart surgery. Open-heart surgery was just beginning. So the surgeons all over the country were in pretty good correspondence with each other by phone and by meetings, but actually, the literature was a year or so behind. In that case, reading the literature was pointless. But the programs were starting up, and they were, of course, run by enthusiasts. A lot of deaths occurred at P and S, and I ended up with an awful lot of those autopsies. I discovered the thing, which, it turns out, no one had ever seen before. I kept bringing these microscopic sections to my chiefs, to the professors in the department, and even the surgical path, and asking them, “What is this? This is a funny-looking thing. What is it?” And I, essentially, was told, “Forget about it, it’s nothing.” But I got curious, and I learned about polarizing microscopes and things of that sort, special stains. And in the end, it turned out that these people were dying of embolization of silicon, which was used to reduce foaming in the oxygenators. And so their arteries of the brain and of the heart were so choked with physical emboli that you couldn’t oxygenate the tissues, and they died.⁴²

So once I became convinced of that, I went back to the profs. Actually, I went to the surgeons, and I said to them this is what was happening, so what could we do? We probably ought to do a few more experiments to really pin it down hard, get some quantitation and so forth. They essentially told me—I think by then it must have been maybe fall—late fall, halfway through the academic year—and they said they could get some free time by about May. So to me that meant, “You mean to tell me, you’re proposing to tell me you’re going to go on killing people for another six months?! The hell you are!”

So I went to the Chairman of Path, a very tough character, Harry P. Smith, from Iowa—not overly impressed by anything in New York. He

Open-heart surgery was just beginning.

said, “Well, you show me what you’re talking about.” So I set up some microscopes for him, to show him, and he said, “Okay, here’s what you’re going to do: Get another dozen microscopes, set them up in the pathology library—.” You know, with the arrows and that sort of thing, the way tests were done back at Amherst: Here’s the arrow, you tell me what it’s on. “And,” he said, “I’m going to invite the Department of Surgery, and I’m starting out with the senior faculty, to have a little meeting with us.” That all transpired,

just as he said. There was some hesitancy to actually enter into the conversation, but he said—in those days, there was a district attorney named

Dan Hogan, who was even tougher than H.P.—and he essentially said, “Either we have the meeting and you guys start doing what Lindberg wants you to do, or I’m going to call the district attorney and shut you down.” So it actually got somewhat confrontational. We did alter the surgical technique. I did do experiments with the surgeons. We did publish them in peer review journals, and everybody agreed.⁴² And my ulcer symptoms stopped right on the spot! [laughs]

JA Life got fun again.

DL Life got fun again, yeah.

JA And somewhere in this time—wasn’t it in medical school when you got married?

DL Oh, yeah, sure. She [Mary Musick] was employed as a young R.N., running the pediatric clinic in Vanderbilt. Yes, the lightning struck when I saw her.

JA So that was what year of medical school?

DL I was third year. It was ’57.

JA And you decided together to stay in New York for your residency?

DL Well, actually, we decided to go first to a dinner in New Jersey. She accepted my invitation to go to dinner and a play, at the Paper



Dr. Lindberg’s parents celebrate his wedding to Mary Musick on June 8, 1957.

Personal collection of Donald A.B. and Mary M. Lindberg.

Mill Playhouse in New Jersey. That took so long to accomplish, since I got lost, that by the time we got back, I had pretty much made up my mind I was going to ask her to marry me. I didn't know what she had on her mind, but the second date was to go to the Amherst-Williams game at Amherst. We did decide on the second date to get married.

JA That is totally remarkable. [laughter]

DL And of course she had to go back up to Amherst to meet Professor Schotté, so that he could assure me of his support.

JA So he was very important in your life, obviously.

DL He's an intellectual father, yeah, definitely.

JA Were there others at that time who influenced you?

DL Well, I think you're lucky if you get one or two great teachers in a lifetime, and he was one.

JA After your residency, then, you had to make a big decision about what to do.

DL Yeah. Actually, I had always intended to leave New York. We left it in 1960. In retrospect, it was quite nice, and it got a heck of a lot worse in the subsequent 20 years. But I was prepared to leave. I wanted a little bit more elbow room. I'd enjoyed Nova Scotia in the summer, for example. So I was prepared to leave the city, and my dad encouraged me to do that. He was from Connecticut, to begin with. He was an architect in New York. He designed big structures, and that's why he went there.

The choice of Missouri was simply because the Chairman of Path at Missouri, Joe Flynn, had been associate professor at P and S, and he'd come back on periodic recruiting trips. Everyone

with a new department is trying to build up their faculty. So I looked into that, as well as Vanderbilt and a few other schools, but I decided that I would go there. Actually, I remember the day I went out for an interview. It was the first time I'd ever flown in a jet aircraft; it was a 707, so that was an excitement in itself. And of course, typical of those days, it left

about three and a half hours late [chuckles], so we didn't make a speedy trip.

But anyway, I was staying in the Daniel Boone Hotel, probably—something like that—and having a pretty nice time of it. I liked

the idea of a new school. I mean, P and S was really a lovely educational institution but it was, by then, somewhat physically old, having been built in 1922.

So, for instance, in running the clinical chemistry laboratories at P and S, in the winter, we would shut down at, well, it would vary, but starting at 4:30 or 5:30.

What would determine the shutdown was when the light was so poor that you couldn't read the meniscus on the Van Slyke apparatus to do PCO₂s. I thought that was a little ridiculous. Whereas Missouri was fine and new—at least in my view—and it certainly had proper lighting and carpeting and stuff like that.

But what really determined me was, I was driving—I suppose I must have rented a car or something—on a particular street, Stadium Road, that we were on many, many times subsequently, and I saw two little boys with cutoffs and bikes and fishing poles. I thought, "My God! What a wonderful town it must be for a kid to grow up in." Mary and I were married; we didn't have any children yet. That sort

of determined me. She was prepared to think along the same lines, that she would like it as well, and we did have a wonderful time in Columbia. That was sort of the fatal allure, that the town is a wonderful

The lightning struck when I saw her.



Newlyweds Mary M. and Donald A.B. Lindberg cut the first slice of their wedding cake, which was decorated with flowers at Dr. Lindberg's request, June 8, 1957.

Personal collection of Donald A.B. and Mary M. Lindberg.

town to live in. In a lot of respects I kept griping about the institution in the sense that it was a new medical school, moving forward fairly rapidly—at least steadily—marvelous Dean, Vernon Wilson. In those days, we were able to say that we were leading the way, and the university was kind of stuck in the mud. I think at the moment, probably the reverse is the case: the university is ahead of the medical school. But like most academic medical centers, it's got a few troubles.

But Vern Wilson was a wonderful guy. It was his first deanship. He was from Kansas, and he was just an incredibly wonderful person to work with. For instance, he had 7 a.m. Monday morning budget meetings, which I attended, since I was on his staff, and it sounds like a pretty horrible thing, but they were the most exciting meetings imaginable. I wouldn't miss one for all the tea in China. We would kind of pump each other up, I suppose you'd say. We'd say, "Well, you know, the university is teetering on the brink of greatness, and we're pushing it over the top," and so forth. For about 10 years, that was a palatable slogan. After a while, we began to feel we were sliding back on it. [laughs]

JA *And what role were you playing then, when you first went as junior faculty?*

DL Well, I was running a bunch of clinical laboratories and teaching pathology. I actually brought an NIH research grant with me. It was one of the few that were at Missouri. I got it right out of a residency, which I'm not sure you can do much anymore—but anyway, I got it. Pathology and infectious disease. It was to investigate a gram negative pneumonia that I had also kind of taken an interest in, maybe even semi-

discovered it, at P and S in New York. NIH liked it enough that they gave me the money, and I brought the money to Missouri and started up a research laboratory. I soon discovered that—I hope you'll excuse a tangent, this is very anecdotal, but maybe that's the point.

JA *That's exactly the point.*

DL Well, anyway, I instituted something they weren't used to: namely, the pathologists were making ward rounds every day on the interesting cultures, seeing the patients with the interesting cultures. Well, I was doing that at P and S with Harry Rose⁴³ and Yale Kneeland, and of course learning every minute I was with those wonderful senior teachers. So I decided that I wasn't a wonderful senior teacher, but I'd just do it, anyway, and let the residents come along. And before we knew it, the internal medicine residents were coming along with me. They hadn't yet recruited medicine faculty in infectious disease. So that was fun.

But you quickly discover the question which is most frequently asked of you is, "What antibiotic should I use?" I mean, you've now got an infection, you've now cultured an organism, you've now done these dumb sensitivity plates, and now they've got little zones inhibiting growth or not inhibiting growth, and so look at it all together and pick a drug to give the patient. And that's the most common—either spoken or unspoken—that's the real question.

I could see at a glance that the currently *in vitro* and *in vivo* correlation was pretty lousy. I mean, to take an example that just is easily understood, Salmonella typhosa is sensitive to any number of drugs. I mean, you get a nice big zone of inhibition around it. But, I mean, if you don't use chloramphenicol, in those days,

I think you're lucky if you get one or two great teachers in a lifetime, and he was one.



Dr. Lindberg's mentor, Oscar Schotté, conducting research at Amherst University, ca. 1954.

Personal collection of Donald A.B. and Mary M. Lindberg.

you're never going to cure the typhoid. So that's an example—there were many others.

And so I started looking into the question of what would be a better way to assess the sensitivity of microbes to antibiotics, and antiseptics as well. In the course of it, a very good thing happened to me. The gal who was running the lab with me—my tech [Jane Reese]—was a beautiful young thing. She had a little bit of a polio leg, but she was lovely, and she was really good; she knew what she was doing. It occurred to me, you know, every once in a while, I would see this sort of horrible beatnik-looking kind of a guy hanging around, and I didn't want to interfere with her social life, but I finally did raise the question, and it turned out, well yeah, that's her husband, who's an undergraduate student. So Mary and I discussed it, and we decided that Jane is a sufficiently wonderful individual that we're just going to bite the bullet and we're going to invite them over to our house. We won't do dinner, because we don't know quite how they would behave. But we'll do dessert and coffee and drinks in front of the fireplace.

Oh, incidentally, we had rented a grand four- or five-bedroom house from one of the faculty off on sabbatical. I mean, I was junior faculty, but we're on top of the mark, Faculty Row [chuckles] temporarily. But anyway, we got this great fire going, we invited Jane, and to make a long story short, the husband turned out to be one of the most brilliant guys I've ever worked with in my entire life, and one of the most interesting, and the most fun. So we sat in front of the fireplace and I told them my interest. He was a second-year—sophomore, in other words—and a physics major.

I started looking into the question of what would be a better way to assess the sensitivity of microbes to antibiotics, and antiseptics as well.

But he had worked for Texas Instruments for some years, so he was older than the typical sophomore. And Texas Instruments had sent him back to school.

Anyway, we invented a machine. We convinced ourselves that we could get these bugs, these microbes, growing in a liquid culture, and then use Rayleigh's law to measure scatter, to get a sense of how many there were. We had a few little technical problems, like we'd have to keep them suspended, and we'd have to move them around and shine a light through it consistently, and have good photometrics. We didn't even think about plotting. But we convinced ourselves that—if I could come up with some money—in three or four months, we could design this machine. And we were right only in that three or four years later we completed the project.⁴⁴

JA And did you get the money?

DL Oh, yeah, I had the money, sure.

JA And who was the young man?

DL Garst Reese was his name. This was a really great thing, and NASA finally orbited the device. I mean, it was doing environmental monitoring. It was a great contraption. We ended up using—of course we were using wall power, 110-volt power—but we used hydraulics to drive the machine and to move the tubes. It's a phase of experimentation that I enjoy, and I regret having to deviate from it. I've forgotten now exactly how it happened: he had to go off and do something else somewhere, and we actually met and worked again together.^{45,46} That was a lot of fun.



Dr. Lindberg (right) consults with a colleague, ca. 1959.

Personal collection of Donald A.B. and Mary M. Lindberg.

JA I have some notes that I must ask you about Fact Bank and the RMP [Regional Medical Programs].

DL Oh, yeah. Well, even before that, though, this business about the growing bacteria, you probably have heard of lag phase growth in bacteria?

JA Uh-huh.

DL This is all nonsense, of course, and people keep saying it. There's a period when the bacteria are growing that you don't see them grow. And then when you see them grow, it's like they're growing very, very fast. And then they reach a level where you can't have too many more of them in the optical density, so it levels out. But anyway, if you get down in and start modeling what's actually happening, then you get into an area of mathematical modeling. And that was the next phase. So I loved that, that was really great. And if you start doing two things—one is logging the output of this experimental device, and then two is running the equations, the model, what's going on inside—I mean, you have to learn computers. There is no other way.

JA What did you have available at that time?

DL Well, very darn little. The university did have a computer center. It had a Burroughs 205, actually, is what it had, which was a paper tape machine. So we started using the Burroughs 205.

Another happy circumstance arose for me, because I wasn't getting ulcers, but I did have kind of a sense of divided loyalty, in that I had this NIH grant, which I felt was a major responsibility. It was my first one, I wasn't going to mess it all up, and I

By God, a computer might be helpful in both cases!

I was assigned 15 minutes a day of computer time.

didn't think it would be good for the university to be dishonest in taking the money [if the work didn't get done], either. So I wanted that work to go forward,

but my job included running these labs—say, for instance, the one I loved most was microbiology—and I would see there in the labs that there were very serious quality-control problems, both in the microbiology and also with medical chemistry. I mean,

we would finish a day sometimes when they hadn't reported anything out. The work was just stacked up. Or in microbiology, it was run by a wonderful, experienced med tech with a master's degree in microbiology, Mrs. Lorah. She could do anything. But there's lots of other people out of lab tech school and so forth. So I mean the bottom line is that I began to think that we couldn't spell *Staphylococcus aureus* the same way two days running in lab reports, which really was an embarrassment to me. And then the chemistry lab just had a problem in reporting stuff.

So anyway, half the day I was trying to do this mathematical modeling with this old 205 and a big string of equations. The other half of the day, I was trying to get the results out of the lab. Finally, it occurred to me, "By God, a computer might be helpful in both cases!" as I was learning the technology, running the equations. I decided, "Heck, let's do

something over in that poor ol' clinical lab," you know? So I developed a system of a presorting, where the message would be broken up into pieces, and each of those pieces would be in a prepunched card, and to get a message out, you'd assemble a set of these cards, and then run it through a reader. That would drive a teletype that would print a message on the ward. And then, courtesy of the university, I was



Mary and Donald A.B. Lindberg with their sons (L-R) Chris, Jon, and Don, ca. 1960s.

Personal collection of Donald A.B. and Mary M. Lindberg.

assigned 15 minutes a day of computer time, which was, of course, a quarter to midnight to midnight. But anyway, I take all these cards over to the university computer place, and by then I also had a 1620, so that would read cards, and read those things in. Then, you've got some kind of a summary. So my own problems were getting simpler, in a way. I mean, I was learning more neat stuff, like the mathematics, and I was getting an improvement in the lab, and the reports were getting out not only the same day, they were getting out within minutes. Besides making the lab reports available more quickly, we had a record of them, so we could start doing some quality control, which we did right away: what's a preposterous range, what's a questionable range, what's a reasonable range? So everything was falling in line, and I was getting happier and happier.⁴⁷⁻⁵⁰

Besides making the lab reports available more quickly, we had a record of them, so we could start doing some quality control.

JA Some people say this was probably the first lab information system anywhere.

DL Oh, it was. Yeah, it was.

JA In the world.

DL Absolutely, yeah.

JA And you told a great story Monday about the NCR [No Carbon Required] paper. Before NCR paper was invented, forms would have carbon

paper in between blank forms and when you wrote or typed the form, the carbon would make sure all copies had the writing or typing on them. With NCR, those nasty pieces of carbon paper weren't needed and the "magic" NCR paper alone was enough so that all copies got written or typed on. It was quite an invention.

DL [chuckles] Oh, yeah.

JA Can you tell the story again?

DL Yes, I've forgotten what made me tell it, but I think it was a question of money, because oftentimes now, you and our various colleagues will be tempted to say to an administrator or manager or funder, "Give me the money for this new computer system, I'll save you a lot of money in medicine." I'm not so sure that in many cases we're really truly entitled to make that claim,

but it happened in the first one I put in. I did save money, and it was a dumb way—as you mentioned, I told the story yesterday. In those days, we would write the reports by hand, let's say, and the name of the organism and the sensitivities, and that would be written on a form, which I guess you stamped the patient's ID on with one of those—

JA Addressograph?



Michael DeBakey at home sewing a Dacron artificial artery, ca. 1955.

Profiles in Science, The Michael E. DeBakey Papers Collection (<http://profiles.nlm.nih.gov/FJ>), courtesy of Baylor College of Medicine.



Dr. Michael DeBakey, James H. Harrison, and Dr. Edward W. Dempsey, ca. 1964.

Profiles in Science, Regional Medical Programs Collection (<http://profiles.nlm.nih.gov/RW>).

DL Yeah, addressograph. One of those plates. That would ink it, and then the NCR would send the image through the three or four or five levels of paper, whatever the heck it was—you didn't have to have carbon paper, because it would go through by pressure. And then the lab would get one, and the record room would get one, and the patient chart would get one. Heaven only knows what would happen to the others. Oh, the billing office, I suppose. So anyway, my system wasn't going to use that; it was going to use the punch-card system and then print on just a plain form, up on the teletypes, where it did all the printing. So I discovered that those things cost five cents apiece, those crummy little NCR papers. I don't know if it all went to NCR, or who got the money. But anyway, we

I wanted to get more practical, I guess you'd say, and get more collaboration.

put in a form—I did use a form for order, but that was designed with a company in St. Louis—I've forgotten its name—but the fellow worked with me on it, and

we got it in for 1.1 cents, roughly, per form. So heck, we paid for the lab system just by eliminating those forms.^{47,48,51-53}

Another happy circumstance in my own education as a manager occurred, because after a year, the university was giving me quite a long leash.

I mean, they were saying,

“Yeah, well, okay, do it. Just do it, that's fine, we'll straighten up after you.” So after a year or so of this, one of the business manager guys said, “You know, doctor, it's customary to bid orders like this paper stuff that you're buying, these forms.” I said, “Oh, really? You mean you'd take the job away from this guy that



Profiles in Science, The Michael E. DeBakey Papers Collection (<http://profiles.nlm.nih.gov/FJ>), courtesy of the White House.

Michael DeBakey with President Lyndon B. Johnson, December 9, 1964.

worked with me in designing it to begin with, this nice fellow from St. Louis?" He said, "I don't know, but we always bid them. Just to see what happens." So they put it out for bid, and Mead Paper Company came back in at a tenth of a cent per form. So that was a real lesson to me about, yeah, you're right—the business guys are right. You definitely want competitive bids on these things. So I mean, we saved, once again, the whole cost of the system. You know, that's a lot of fun.

On the other hand, I also learned that it's tough to get the praise from your colleagues, like getting the report in readable shape and available within half an hour of having been completed, was immediately followed by the question, "Why isn't it there right away?"

JA *"And what can you do next?"*

DL Yeah, "What have you done for us recently?" So of course, that is typical of computer work. I mean, people adapt very, very quickly, just as we all adapt to the increasing speed of the machines and the greater capacity for memory and all the other nice features. You accept those quite happily and just ask for more.

JA *I love that story. So what came next: the various decision-support emphases, or Fact Bank?*

DL Well, Fact Bank was part of Regional Medical Programs. I was very happy with this whole circumstance, but one thing I knew was missing, and that was contact with industry. Of course, I

was, by then, doing some consulting with IBM and companies like that. So I could see right away that this wonderful academic set-up in the university ought

Some of the new discoveries in those days, for instance, were myocardial infarction research and surgical intensive care units.

to be matched with research with the companies, with industry, because we had a terrific power in the sense that we had a medical school, we had an ag school, we had a journalism school, of course the chemists, and all of them were very, very good. The business school, even, was very, very good. The med school was the youngest guy on the block. It made it a very exciting campus. The dental school, unfortunately, was in Kansas City. The nursing school was

in Columbia with the med school, of course, so it had really a terrific environment. And we had good collaboration with the engineers, but we didn't have any contact with industry, and I thought that was a mistake, and I started griping a little bit about that. I wanted to get more practical, I guess you'd say, and get more collaboration.

And about that time, Regional Medical Programs came along. That was 1965. It stems, as you probably know, from the report on heart, cancer, stroke that Michael DeBakey⁵⁴ ran, on the request of Lyndon B. Johnson. But in the end, Regional Medical Programs came out of it, and also the Medical Library Assistance Act. But I just fell in love, again—I guess I'm an incurable romantic—with the idea of regional programs, that the regions of the U.S. would know best what suited them. It wouldn't take any kind of genius to observe what's good for Manhattan Island in the middle of New York is not necessarily what you want in Columbia, Missouri, in the



Personal collection of Donald A. B. and Mary M. Lindberg.

Dr. Lindberg with his son, Jon, exploring Aspen while there for a Given Institute Lecture, ca. 1965. In an oral history interview on October 4, 1994, Dr. Donald West King recalled the origin of the Given Institute Lectures: "While at Colorado, in order to attract more people and to provide a further education for young people in the school, we developed an institute at Aspen, Colorado, called the Given Institute of Pathobiology. For a period of six years, we were able to attract many of the foremost molecular biologists in the world to summer conferences, and provided a basis for communication among very small groups in this field that was just emerging." (King DW, Kennedy CS. Full text of "Dr. Donald West King Oral History Interview" [Internet]. Armed Forces Inst. Pathol. Oral Hist. Progr. 1994 [cited 2015 Mar 20]; Available from: https://archive.org/details/usnavybumedhistoryoffice_gmail_King)



Profiles in Science, Regional Medical Programs Collection (<http://profiles.nlm.nih.gov/RW>), courtesy of Edward A. Hubbard and National Institutes of Health.

Meeting of the National Advisory Council on Regional Medical Programs, February 9, 1966.



Profiles in Science, Regional Medical Programs Collection (<http://profiles.nlm.nih.gov/RW>), courtesy of Jerry Hecht and National Institutes of Health.

Dr. Robert Q. Marston, Wilbur Cohen, and Dr. Hudson at a Regional Medical Programs meeting, ca. 1968-1973



Profiles in Science, The Michael E. DeBakey Papers Collection (<http://profiles.nlm.nih.gov/FJ>).

Mary Lasker visiting Michael DeBakey at the hospital, ca. 1970s.



Profiles in Science, Regional Medical Programs Collection (<http://profiles.nlm.nih.gov/RW>).

The Fact Bank, providing “Fast Access (To) Current Text, via Mosler 410, ca. late 1970s.

middle of Boone County. And you can repeat that for every area of the country.

So anyway, Regional Medical Program had the idea that it would essentially pay for an analysis and planning by people in regions, which were to be self-declared regions. It had an underlying theme, from lab to bedside, so to speak. In other words, get the new discoveries out there and in use. Some of the new discoveries in those days, for instance, were myocardial infarction research and surgical intensive care units. That was a new idea that didn't exist in most hospitals, for sure, in Missouri.

So the man who was head of the medical school, Vernon Wilson, he was Dean—I guess, later, Vice-President—was an important person in regional

medical programs and teaching us how to organize those matters, and also how to get the Washington side writing the legislation and the appropriations correctly. But the net result is that Missouri was one of the first four planning grants granted for regional medical programs, and I think it was the first or second one actually funded in operation. So that solved the problem of resources and a reason to work with the engineers and the others. That was a very exciting period for me.

One of the many projects was a project called Fact Bank, which Larry Kingsland, Sr., introduced. I had recruited him, I think, from the Navy. He was a pediatrician, very fascinating man. He undertook this. He actually—maybe he really fell in love with it more

than he should have, because I can remember yards and yards and yards of brown butcher paper on which he would write down what we now call concepts, for unified medical language—we call them concepts and give them CUIs [concept unique identifiers]. But anyway, to do all this on paper, when you couldn't do anything with a computer, was a little bit of a frustration for him and everyone around.

I came up with one way that I thought would help him do this Fact Bank thing, since, as I say, the computers were not really up to it, and the software, of course, was enormously awkward and very expensive to develop. I mean, I think many times now, when you can take off the shelf for 20 bucks a little database program or such, that we would have paid hundreds of thousands of dollars to produce codes like those. This is really remarkable.

But anyway, there was a thing called the Mosler Safe Company, which had a thing that automatically brought up microfiche. And of course they developed it for sale to the banks, so that the signature of the person could be quickly brought up, and you could verify the check. I, of course, didn't care anything about that, but I was thinking, on that microfiche could be the facts about the treatment of cancer, or something like that. You could bring it up, pop it up and see it, and maybe even make a copy—we were doing that. So the facts got put onto those things. It worked, in its own fashion.

JA Now, I'm a little confused. What was your role with the RMP [Regional Medical Programs]? You were teaching pathology.

DL Yeah.

I think many times now, when you can take off the shelf for 20 bucks a little database program or such, that we would have paid hundreds of thousands of dollars to produce codes like those.

JA And you were, in your spare time, getting into the information sciences?

DL Yeah.

JA How did this all work?

DL Well, I mean, I think it would be fair to say that I was in charge of anything the Regional Medical Program had to do with computers. And I also was running the computer center. So, it was like three jobs.

JA You were running the computer center?

DL Oh, yeah, I started it.

JA You didn't tell me that.

DL That's true. I guess that's right. But in order to do, say, this lab thing, you needed a computer center. And so the Dean said, "Well, why don't you start one?" And I said, "No,

I've got too much to do, I've got to do this research, and do this teaching, and do the stuff." But it sort of bothered me. It kept clawing away at the back of my mind, and it finally reached the frontal lobe, and it said, "You know, bud, if you don't do it, somebody else is going to do it, and they'll probably mess it all

up, and you won't like it." So I remember I was having lunch in the faculty cafeteria. I went over to the telephone on the wall, and I dialed up the Dean's office. In those days, you could actually dial up Deans, and they actually talked to you. He picked up the phone, and I said, "Vern, I'll do the computer center." He said, "Okay, I thought you would." [laughter]



Personal collection of Donald A.B. and Mary M. Lindberg.

Dr. Lindberg in Aspen using a TTY 110 baud, with Lloyd Morriset and Sam Garten, ca. 1965.

JA It's all yours! Along with everything else.

DL Yeah. That was a tremendous amount of fun. We put in an IBM-1410. It's an interesting, nice machine, but the university itself only had a 1401.

So there was a lot of jockeying for position to get that thing done. And Vern also was great at that. We got it on the grounds that for a certain number of minutes or hours or whatever it was, for a week, that the university guys could come over and use our machine to write checks—payment, salary checks. [laughter] That was a lot of fun.

JA You were a chief information officer!

DL Yes, although I'd never take a job with that title.

JA Then the decision-support piece of it?

DL Yeah. Well, you know, the hardware is always lots and lots of fun—but the software is the tough part. If you're doing, say, the quality control on the lab part, well, how do you organize that knowledge, and what is it you're checking for? And if you're going to alert people to potential errors—. Now, mind you, this is 1962, so we didn't have any books from IOM [Institute of Medicine] talking about “to err is human;” we just knew what sloppy lab work was, and we didn't want it. So that was kind of a step in the direction of getting your software mind a little bit more sophisticated. I actually ended up being a lifelong friend of Ed Feigenbaum about that time, because I was asked by NIH to be on a study section, and he and I were both assistant professors. We were kindred souls. And Ed was, even then, a real expert in artificial intelligence, and a colleague of Joshua Lederberg⁵⁵ and Carl Jursi and all those

You know, bud,
if you don't do it,
somebody else is
going to do it, and
they'll probably
mess it all up, and
you won't like it.

guys. So we kind of fell in together and started doing some projects together. That got me started in the artificial intelligence business. Josh actually asked me to chair the advisory committee for the Stanford artificial intelligence program, SUMEX, to evaluate the applicants from other universities to use it. Sort of a long story. Anyway, I certainly learned more than I ever taught anybody else in that field.

And then that got to be a national program. SUMEX, that's a long story, too. But anyway, SUMEX got a good bit of money from NIH, and part of the deal was that, well, 40% of the time was assigned to Stanford, 20% of the time was assigned to systems

people to keep the poor machine together—it was a DEC-10—and another 40% was assigned to the rest of the country. And so I chaired the committee that evaluated proposals to use that 40%—as it turned out, to adjudicate which partition programs would best go into. And shortly, Rutgers was the other NIH-supported AI [artificial intelligence] program.

They're all very compatible people and good friends with Stanford people. So very shortly, we were really doing the entire country between those two machines. It turned out that the AI work that I was interested in doing was more to the liking of Cas Kulikowski and Saul Ameral and Sholem Weiss and so forth, at Rutgers. So I was a chum, if you will, of Ed's and Josh's at Stanford, but I actually did the collaboration much more extensively for the next 15 years or so with Kulikowski and company at Rutgers.

He didn't say, “What are you trying to do?” because AI is just a technique; it doesn't tell you what to do with it. By then, what I wanted to



Joshua Lederberg in front of exobiology equipment at Stanford, ca. 1965.

Profiles in Science, The Joshua Lederberg Papers Collection (<http://profiles.nlm.nih.gov/BB>), courtesy of Stanford University News Service.

do was medical reasoning. There, too, as you know, all these allegedly professional developments really hinge upon who you're sitting next to at a railroad station or who you meet in an airport or something. Since I had been repeatedly at Stanford, the President put me on the computer science advisory committee or something like that, a visiting committee. So I'd be there periodically. One of the people I met was Gordon C. Sharp, who was a professor of medicine but an expert in arthritis and rheumatology. He ultimately got recruited to University of Missouri to set up a new department there. I would keep meeting him on airplanes and in airports and so forth. After about three years, I said, "Gordon, this is ridiculous. Let's get some research going. What the heck is the point sitting around here talking about it in airports?" So we started a series of seminars, which would be alternately hosted by his clinical people in rheumatology and my, by then, computer group. Our operating philosophy was, we will meet until a researchable project rises from the meeting. And pretty soon, the researchable problem came to be, how about an artificial intelligence program that understands 105 diseases in arthritis and the muscular-skeletal field and can, given you tell it the findings, help you come to a diagnosis? And that was very much in keeping with the strategy of that day. It turns out, it really was a flawed strategy, because, I mean, it was sort of measuring the doctor against the computer, whereas I think we now understand that a much more informed view would be the doctor and the computer versus the doctor alone. I mean, at least it's slanted toward the hope you're going to be better.^{3,56-59}

But anyway, we had a lot of fun with that particular program. I won't attempt to summarize 15 years of work quickly, but to me, the best summary, because

All these allegedly professional developments really hinge upon who you're sitting next to at a railroad station or who you meet in an airport or something.

I think we now understand that a much more informed view would be the doctor and the computer versus the doctor alone.

it was one that I liked, was when Gordon—I've forgotten why it was—reviewed all of the residents and all of the postdoc fellows, all of the people he had trained in 15 years in his work at Missouri, because, I don't know, maybe they were going to have a party or something like that. And he said, "You know, Don, it is

absolutely amazing [raps table for emphasis] that the absolute best, top-performing people in this entire program are the ones that worked on this computer team with us."

The computer work involved all the stuff that you can easily imagine: programming and testing and all that. But the real tough thing is getting in the clinical observations. And that, I'm afraid, up until this day, is done about the same way: namely, in the evening, with pizza, and reviewing charts, and writing out data sheets, and entering

it in their own computer. So there were hundreds and hundreds of hours like that. It's one of the things that no one has to convince me about, that a computer-based patient record is the way to go. I mean, that's very, very clear. We didn't have that. We had, actually, quite a bit, but we didn't have enough. So anyway, that was how the thing got worked, with Gordon Sharp. And as I say, he was proud to say that the very best people he trained were the ones that worked on this NIH AI/RHEUM project.

JA I'm still unclear as to why.

DL Why do it?

JA No, why that happened. Were these the best people to start with, who were attracted to this project, or did the project somehow make them better?

DL Well, we think it was the latter, but of course any truly honest evaluator would phrase the question just the way you did. I mean, was it preselection? I don't

know, maybe. I guess we'll never know. But I was happy that at least we didn't make them any worse! [laughter] A couple of them won prizes and so forth. No, they were wonderful people, and it was a really, really, really wonderful time, because in the case of the thermo, which is what we called that math model of chemistry, and AI/RHEUM—in both of those cases, we were sort of pressing, if not the computer hardware, certainly the computer software. I mean, stuff would be falling apart all the time. And that was fine. Then the machines would get better, you'd get 360-50s [IBM System/360 Model 50 computers], and that was swell. A certain collegiality lived in the medical world. So, for instance, we had a 360-50, and they had a similar machine at Baylor, in Houston, and Alan Levy was in charge of it there. So we would ship each other interesting software. There was a system that he called BEST, Baylor blah, blah, blah—Baylor something—time share of some sort. And it was very good, so we used that for a while. But both of us had difficulties.

I was still being a computer center director in those days, so I had a team of three or four people who would pick up crashes. In other words, the machines would just go down, and then someone would have to go back and piece the whole thing together and figure out how to get continuity in the files and so forth. But we also were overusing the machine. I could tell you a lot of what, to me, was a good education on how you measure those things. But in any case, I finally got to a point where I could justify, by piecing together different pieces of funding, that I could go from a 360-50 to a 360-65. I think that we really just inherited the university's 360-65, and IBM handled the paperwork. It had two channels on it. But the bottom line was that 65 was so [raps table for emphasis] infinitely more reliable than the 50, that

A computer-based patient record is the way to go.

we had nothing for those four people to do [now that the computer wasn't crashing so much]. We had to find a new assignment for them. I mean, it made that much difference. It didn't have a darned thing to do with whether you were medical or university; it was just a heck of a lot better machine. And Baylor, I think, had the same experience.

JA So you were having all this fun.

DL I was having fun, yeah.

JA You were having a great time, and somehow NLM came into the picture?

DL Oh, well, quite a while later. Actually, by the time Ed Feigenbaum and I were

getting sort of off the study section, we had both become happy members of the former computer center directors' club. I enjoyed it for about 10 years, but that sort of wears out. It isn't the work, it's the attitude, because most of those things have some kind of financing, but most of them have, basically, a revolving fund—at least that's what I came to. You know, there would be various ways you could say it, but what I asked the Dean for was a revolving fund, and that essentially meant that you start out spending money, and after three months, you have a little meeting, and you're obviously behind, and you've got to pour in the money from someplace and crank the

thing back up to zero. So it was kind of—it wasn't exactly like roulette, but it was okay, totally okay, except that every once in a while, you would catch yourself mentally saying, as a colleague sat down across the desk from you to discuss a research project, the Brooklyn end of your mind would be saying, "I wonder how much money the guy's got." [chuckles] Rather than, "Is this a really challenging scientific idea?" So I finally concluded that was not a



National Library of Medicine collection.

Frances Humphrey Howard was a special assistant to the associate director for extramural programs at NLM from 1970 until her retirement in 1999. The sister of the late Vice President, Hubert Humphrey, and a force in her own right, she was instrumental in the creation of the NLM's National Center for Biotechnology Information, which was officially established in 1988.

good influence and that I should stop being a computer center director.

We got a very, very talented guy named Peter Reichertz, actually from Germany, to take over running the computer center. He did very well with it. He had an abrupt start-up, though. [chuckles] He was a very, very able guy; he did a lot of programming himself and is a brilliant fellow. He made the announcement after the first few days that henceforth, everything would be written in PL-1. And some of the staff sort of came around the corner to ask me about that, and I said, “No comment.” [chuckles] That’s like

ordering the waves to stop. I mean, you can say it, but you can’t do it.

So I retired from that to do more research and more of this AI stuff—and other plans, but happy ones. Ultimately, NLM did come recruiting. They originally came recruiting for the Lister Hill Center Director job, which is a very, very good job, of course. But for various reasons, I wasn’t ready to do that. By the time they were actually recruiting for the Director of NLM, I guess two of our three boys were through college, so that made the decision a little bit easier. We still loved Columbia. On the other hand, I was kind of—I didn’t



CANCER TEACHING DAY — Two hundred attended a teaching day on uterine cancer sponsored by the Lakes Area Regional Medical Program and the Genesee County Unit of the American Cancer Society at the Holiday Inn Thursday. From left, Dr. Laurence G. Roth, chief of obstetrics and gynecology at Genesee Memorial Hospital; Dr. Marie

Gamarra, cancer research pathologist and Dr. Stephen Piver, associate chief of gynecology, both of Roswell Park Memorial Institute, Buffalo; Dr. Colin Poulter, assistant professor of radiation therapy at the University of Rochester and Patricia Shine Hoff, RN, MA, director of nursing and allied health affairs, Lakes Area Regional Program, Buffalo.

Profiles in Science, Regional Medical Programs Collection (<http://profiles.nlm.nih.gov/RM>).

Regional Medical Programs Cancer Teaching Day. “Batavia Daily News,” (20 October 1972).

like apologizing for my own institution, and there were a number of circumstances in which University of Missouri sort of stubbed their toes.

I had been on an NLM study section, of course. I probably didn't say that, but anyway, I was. A great study section. As you know, you learn a huge amount from those experiences. And I'd been on a few other special things NIH had asked me to do. So I knew that NLM was absolutely a super place. I was surprised that they could recruit in the vein of a university, although you can't negotiate salaries, unfortunately. But I found that people I respected from industry and from other universities were calling up and saying, "Now, wait a minute, Lindberg, you gotta do this. Let's get serious here, let's get you here to Washington." So I at least thought I would give it serious consideration.

I asked Mary how would she like to live on half salary. I think she said roughly, "I'll live on half salary if it's an institution we can really be that proud of." So the appeal to her was not Washington—she grew up in Chevy Chase and by then, wasn't much of a fan of Washington, because her mother continued to live there, and had a chronic disease, rheumatoid arthritis, as it turned out—so just about every time Mary was back in Washington was to care for a mother who was worse and worse and worse off. So she had developed sort of the wrong emotional connection with the town. It wasn't a question of, "Oh, I'm glad to get out of Columbia, Missouri, I'm glad to get back to Washington." Quite the reverse. I mean, the house we built in Columbia was meant to last a lifetime. It's probably the best house in the county. I designed it, drew the lines on a piece of paper, and we supervised the building of it. So we were totally delighted with that.

But on the other hand, NLM is great, a unique place. Like most of the other people at NIH, people are there because they can do something they can't

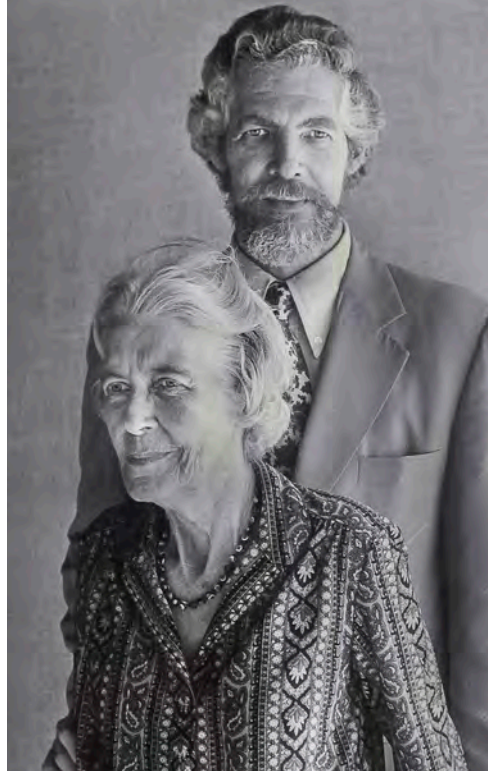
do anywhere else. That's the real appeal. And money-wise, it takes you a couple of years to figure out the answer to a question like that [about living on half salary]. People will tell you right away Washington's a very, very—real estate—very expensive place. But actually, good real estate in Columbia, Missouri, comes pretty high, too! [chuckles] I remember people

telling me, "Now, wait a minute, Lindberg. Wait till you encounter the bureaucracy of the federal government." And I thought more than once, "Man, if they've got any more bureaucracy than a state university, I don't know how in the hell they do it!" [laughs]

JA What do you think now?

DL Well, it isn't the bureaucracy problem. It's a problem if you're between the White House and the Congress, which every new administration seems to have that dispute, until they finally figure out that the President requests and the Congress appropriates. But until they get that settled, it can be awkward. But that's not bureaucracy. I would say the running of NLM, the running of NIH, is not a bureaucratic problem. I mean,

it's less complex than a four-campus university, by far. I can remember in these 7 a.m. Monday morning meetings that I spoke about, we would have people—once Vernon got to be Vice-President—from all the campuses. And somebody would say something halfway cheery, and he would say, "Okay, buddy, what did you do to make it easier to transfer credits between the four campuses of the university last week?" You know, here's a simple matter, conceptually very easy. It doesn't take six PhDs to understand it, but golly, in most schools, the students are just there. They are really [stuck] behind the bureaucracy. Like the [attitude that] English credits from this town, this branch of the university, can't possibly be as good as the English credits from the mother campus. So no,



Dr. Lindberg with his mother, Frances S. Lindberg, ca. 1974.

Personal collection of Donald A.B. and Mary M. Lindberg.

[compared to the university,] I didn't find bureaucracy to be a problem at all at NLM.

JA Well, I'd like to get a picture from you of what NLM was like when you first went there.

DL Well, one of the things that was a big appeal to me, frankly, was [Deputy Director] Kent Smith, because I sized him up, by inspection, first-class guy. And I could also see that his goals were complementary to mine. I asked him, explicitly, "Smith, what is it you really want to do, what's your goal here, what's your ambition?" Because I was thinking, "If you're somebody who wishes he were a doctor, or wishes he were a nurse, or wishes he were a biochemist, or some damned thing, this is different. I may get myself another deputy." But he said, "I'll tell you my goal. I'd like to make this the best-managed unit in federal government." I thought, "Wow, that's great." So Kent definitely was himself. He knows lots and lots of things, but he considers himself [raps table for emphasis] a manager. So that's what he brought to that job, and that was a very appealing thing.

For the rest of it, I mean, I knew people from the study section, so I knew the research and that. I knew how good the systems were, but they had gotten a little solidified, I suppose you'd say. For example, they were quite proud of the

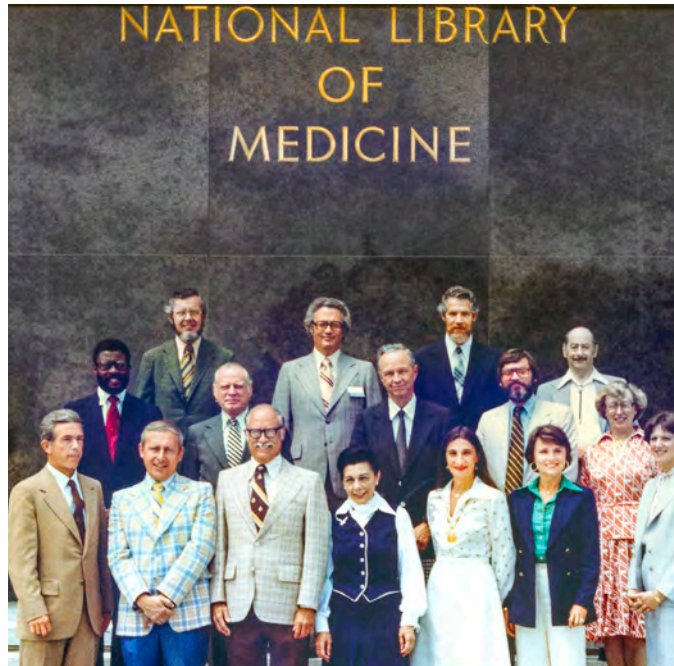
MEDLINE services, such as they were. As you know, ELHILL was a system so bloody complicated that they used to send medical librarians for six weeks to

learn how to compose those stupid searches. But on the other hand, I think they could rightly claim it was an important thing, a major service, quite something to be applauded. I remembered asking the guy who was running the comp centers, and also saying to Lois Ann Colaiani, the library operations person, "You mean to tell me that you have this thing that's so important, and you run it from nine o'clock in the morning till five o'clock in the evening, Washington, D.C., time, and then

you stop?! Haven't you ever heard of California? Hawaii? What are we doing?!" "Oh, well, you've got to understand that we need eight hours, and we back things up," and we this, that, and the other thing.

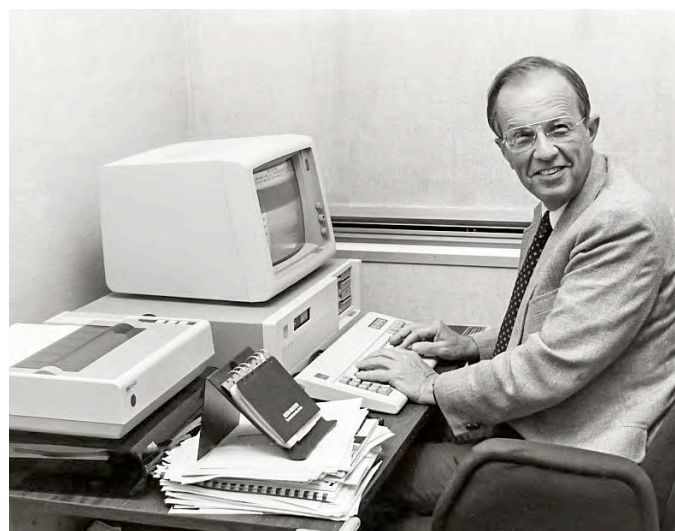
I finally had a meeting with the comp[uter] center director of whatever it was called—OCCS [NLM Office of Computer and Communications Systems], I guess—[John] Anderson—and I said to him, "We've got to do better on this. We've got to be extending this stuff." Well, you know, [he told me]

all the troubles. So anyway, it turns out, you know, [I asked,] "How do you have the core organized?" Well,



Dr. Lindberg (top row, R) attending a study section meeting at the U.S. National Library of Medicine, ca. 1980.

Personal collection of Donald A.B. and Mary M. Lindberg.



Kent Smith at his computer, ca. 1980s.

National Library of Medicine collection.

it was organized on four partitions. I said, “Okay, fine. Then one of the partitions can be doing something different from those other damned partitions. And it can certainly do it different at night, when your load is lower.” So anyway, we started working on that. I said, “Okay, now we got a method. Now go implement a method such that it goes for eight hours plus 15 minutes. Let’s see how that goes.” Well, of course it worked. So we had another meeting. “Let’s add”—you know what to do—“let’s add 30 minutes.” After a few of these meetings, he finally came back and said, “Dr. Lindberg, I understand.” [laughter] So, I mean, that was one part of it.

Then on the professional level, it was kind of amazing, because they had these machines—maybe I can think of the name of them—a little microprocessor machine with a big CRT [cathode ray tube], and all it would do is text process. Wang—that’s what they were—Wang. So they had scads of these Wang machines, and that was crazy because inside was a perfectly capable general microprocessor. But Wang

was in the business of selling text processors, so there they were, that’s all the hell they were doing. So, anyway, by then I had fallen in love with IBM PCs, and I wasn’t a Mac guy in those days, because the Macs were all little brown boxes, and I didn’t like that. Anyway, actually, I had at home a DEC-11 that Larry Kingsland set up for me when we were in Missouri, and I loved that—until the day I ordered an IBM PC. It came in its boxes, and you unpack the boxes and put them all together and woke up this machine, this magic machine. So I never turned on the DEC-11 after that. Strictly stuck with the IBM PC.

There were two deputies, Kent Smith and Harold [Hack] Schoolman, and so I said, “Well, I’ve ordered a PC for each of you. And the best way to do it is if you put it together yourself.” I mean, they, of course, had lots of engineers and people who would do that for them, but I said, “It’s much, much better if you put it together yourself, you read the book, it’s very simple. The advantage of it is”—and I could see that this was already happening—“none of these software jocks



Personal collection of Donald A.B. and Mary M. Lindberg.

Dr. Donald A.B. Lindberg was sworn in as the 19th NLM Director on October 11, 1984. NIH Director James B. Wyngaarden administered the oath of office. Mary Lindberg and one of the Lindbergs’ sons, Jonathan, also participated in the ceremony.

can come around and pull the wool over your eyes the way they've been doin', about the magic of compilers, and the magic of this and that and the other thing, because you will see it's a bunch of junk that you stick in a socket and wire up and put it in the wall, and it runs. And that's all it is." So [laughs], they were good fellows, and they said, "Oh, yeah, sure, we'll take care of it." The approach that they took in common was, in each case, they brought their wives in to read out of the instruction book when they put it together. [laughter] Hack got the A and B drives reversed. They lived their whole life reversed. [laughs] He never bothered to fix it.

Kent Smith told me long after all this had transpired, "You know, it's really funny, because I am interested in computing. And that's the major factor at NLM, but I actually put in travel orders to go to a course"—and I've forgotten where he was going to do it, some university place, to take a quick course,

like a long weekend, or one week, or something like that—"on computers and what it's all about." The Director actually turned him down. He said, "Look Smith, I want you here working, not playing around with computers." So he took it as really useless. Of course, the Director was a marvelous guy, but in that particular case, we just made a different call. From Kent's point of view, he had changed from a system in which he wasn't permitted to go and learn about computing, to one where this mad Director was telling him to assemble this blasted microprocessor. [laughs] But I think that he got out of it exactly what I hoped he would get out of it. He was a lot tougher for these guys to deal with. I mean, they couldn't bluff him. When you know that all there is under the hood is this crap that you put there and wired up and plugged in, it takes a lot of mystery away, in a good way.

JA Obviously, when you went to NLM, people knew your background, and you were hired because of



Profiles in Science: The Joshua Lederberg Papers Collection (<http://profiles.nlm.nih.gov/BB>).

Joshua Lederberg at a LINC computer teletype, December 1974.

that. So there must have been change in the air for you to have been recruited to start with.

DL Well, NLM was an advanced computer operation before I came to it. It's just that there's a lot of changes that occurred subsequently. We had to keep up. It was quite proud of itself, and viewed at NLM and NIH as the computer place. I don't know that they thought they were hiring a computer guy. I'm not sure what they really thought.

JA Well, you were doing AI...

DL But you're not hired by anybody in NLM, you're hired by a whatever you call them—recruitment team from across NIH. So I remember, actually, one of the guys on it was the Deputy Director for Intramural Research—very nice but tough old guy, long white hair. I remember in this fairly brief interview, I said to him—Ed [Rall] was his name—“Ed, what do you think I need to be doing with NLM?” And I think he said, in his own gruff way, “Well, you know, if you don't do anything with it, that would be a terrible big mistake. And if you change everything too fast, that would be a terrible big mistake.” Something like that. So I thought it was an informed view, that you had to change with the times, the times were changing, someone had to figure all that out and do it, but that it was a very fine place, but it couldn't stay the way it was—couldn't. NLM had just finished a very bruising battle with these damned publishers, particularly financed by Elsevier but led by Williams and Wilkins.⁶⁰ And so they were concerned about how

ought that to be handled. That we did discuss. I think they were satisfied with my more-or-less Brooklyn answers to their questions: namely, I wasn't about to be pushed around by the publishers.

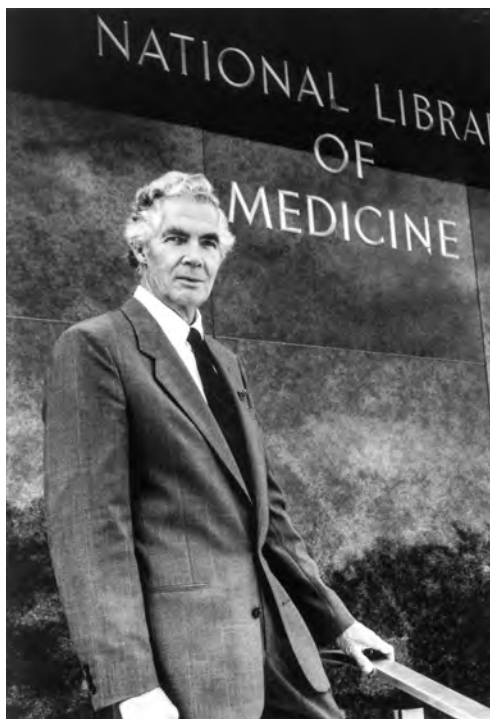
My focus now is more on patients, families, and the public—but then it **was definitely on the doctors in a clinical decision-making set-up where information could influence patient care.**

JA When you arrived, did you have a particular vision of what NLM should aim toward?

DL Well, I can tell you my mental model. I said it before, but truthfully, my mental model was this is a really wonderful institution, it's doing a grand job, I didn't come here to change a thing. I didn't have in mind to change a thing. And my mental model of it, really, was something like the Queen Mary—you know, [captaining a big ship that was] putting out to sea. I was thinking that I could walk out on the deck once in a while and say, like,

“Mr. Smith, take her to point starboard.” Whereas in fact, it was more like being en route on the Beltway in rush hour. [laughter] In other words, if you don't

do something pretty alert every four or five minutes, you'll drive the damned thing off the highway. And that was a big surprise to me. In other words, the number of opportunities to destroy the institution were very much larger than I thought of initially. So the model of just calm and cool at the wheel was not right at all. There were lots of problems. I mean, of course, everybody has personnel problems, but I mean if you have a small staff, you have a small set of problems. If you have a thousand people, you've got a thousand times more problems. There is no personnel operation that isn't full of problems, because of all the things you probably know: employees have families, and



Donald A.B. Lindberg standing on the steps of the National Library of Medicine, in Bethesda, MD, ca. 1984.

Personal collection of Donald A.B. Lindberg and National Library of Medicine collection.

they have financial troubles, and they have illnesses, and competitions, and unfair selections, and wise selections, and all that kind of stuff. So that alone does it. And then there'll be people pushing the Congress around in various directions. So there's lots of opportunities to do things wrong. And that amazed me, but that's kind of exciting, that's okay. I can drive on the highway. [laughter]

JA What was your vision then of what NLM could do? You're known as being a visionary, and being probably 20 years ahead in your thinking.

DL Yeah. Well, I mean, one thing that became obvious at a glance—and you would have, I think, come to the same conclusion—is that ELHILL was a pile of spaghetti code that you shouldn't expect a human being to deal with. By then, it was something like 175 PL-1 programs, basically, that were written for batch processing, that had been forced together into a more-or-less online system. But you know perfectly well, you couldn't even recompile half of those damned things, let alone make them interact. The documentation—whew! So the first decision to be made was, are we going to keep on with this nonsense, or what the hell are we going to do? Because my idea was that we've got to get systems that'll serve the doctors. That was what I was after, the healthcare professionals. Maybe I was overboard, because subsequently I would say

I think that IAIMS had networks because I put them in, and it was pretty late in the game.

my focus now is more on patients, families, and the public—but then it was definitely on the doctors in a clinical decision-making set-up where information could influence patient care. There were actually a few doctors who had spent six weeks in this ELHILL training program, but that's—I don't say they're the lunatic fringe, but they're not very numerous.

I felt that a very high priority was to solve that thing one way or another. And there were people at NLM on both sides of these questions. But there were people who could imagine the solution that we ultimately picked, which was essentially leave ELHILL alone, because it is running, and it's running pretty darned efficiently. But imagine ELHILL as designed to talk to other computers, not to people.

And let's imagine something that hops on the front of it—which, of course, became Grateful Med^{61,62}—that is designed to talk to people, and then give the orders to ELHILL to do the work as a back-end system. So that became a very, very interesting project.

As you know, any change you make, some people—there's naysayers no matter what. I guess I was somewhat disappointed at how strongly the hospital medical librarians felt that Grateful Med threatened their very existence—which, of course, we had no intention whatsoever to do. It was strictly designed to be some kind of a tool in the hands of practitioners that they could use to catch up with the literature.



Personal collection of Donald A.B. and Mary M. Lindberg.



Personal collection of Donald A.B. and Mary M. Lindberg.

Lawrence C. Kingsland, III and Donald Lindberg demonstrate the AI/RHEUM system (left) and visit at the Lindberg's home (right), ca. 1985.

So, it was a lot of fun, and we went through various versions of it, but I remember how proud we were when the first version went up. There were certain innovations in the managing of that, because the former systems had all been written by programmers for programmers, whereas this was written for doctors. Rose Marie Woodsmall, for instance, became the person who was in charge of talking with users, and really talking with users and seeing what they're really doing, and what helped and what didn't help. So that was a lot of fun, but I'm sure that I was never so appalled as a year or two after that system, where we went back to version one, that was originally something we were proud of, and then subsequently something we thought was childishly simple. Of course, that's the way all the things are right now, where we're proud of stuff now, but five years from now, my gosh. "You had to type all this stuff? You couldn't talk to the machine?! Or didn't the machine know what you wanted?!" So that was a fun period.

JA So Grateful Med was quite early on in your tenure at NLM?

DL Oh, yeah, we started on that right away.

JA And IAIMS [Integrated Advanced Information Management Systems] must have been as well?

DL Well, IAIMS⁶³ actually came out of an AAMC [Association of American Medical Colleges] commission or study or group—whatever the hell it was on. I was on it, as well as Nina Matheson,* and it became known as the Matheson Report,⁶⁴ because she worked for AAMC at the time it was put together. I can remember very well, toward the very end of it,

we were going into more or less the last version of the damned thing, and she said to me one day—I was on the faculty of Missouri then, of course, not in NLM—something like, "Well, you're kind of scowling a little bit about this. What are you thinking?" I remember telling her, "Nina, the thing is okay, but it doesn't have anything about networks. It's got to have networks.

The word isn't even there, the concept is not there. It's got to be networked."

Now, in a way, I was reaching for concepts, too, because you couldn't buy something called a network. I mean, a network was like wires that started here and got screwed down. I mean, I had built networks, but they were physical, as well as conceptual in software. So anyway, I think that IAIMS had networks because I put them in, and it was pretty late in the game. [chuckles] And Nina, to her credit, said, "Well, okay, I think you're right."

JA And you're a visionary!

DL Yeah, to that extent. So IAIMS is something that NLM inherited.

They, of course—NLM—had commissioned the thing of AAMC: "Make a plan to do this kind of thing." Actually, Marjorie Wilson was the whole moving force behind that. Marjorie had been Associate Director at NLM—I've forgotten the precise title, but I know she was an Associate, maybe Deputy Associate, I think. And then she went over there to, I guess, to AAMC, to get the thing going or something. And then subsequently, she went to another agency. But she was the one behind that. We inherited it, basically, and then implemented it. But even there, to get the first four of these things, to get funding for the first four, I don't think it would be failing to respect any privacy to tell



Reprinted from Texas Medical Center News, 15 Nov 1998; 20(21).

Donald A.B. Lindberg, MD, NLM director; Naomi C. Broering, MLS, MA, Houston Academy of Medicine/Texas Medical Center (HAM-TMC) Library executive director; Deborah D. Halsted, MLS, MA, KNS HAM-TMC Library assistant director; and Tenley Albright, MD, NLM Board of Regents (BOR) chair. In November, 1998, Dr. Lindberg announced that 37 public libraries would take part in a multi-state pilot project designed to increase public awareness of and access to health information via the Internet. The Houston Public Library was one of the 10 participating libraries in the South Central Region (SCR) of the National Network of Libraries of Medicine (NN/LM). (Halstead D, Varman B. "National Library of Medicine announces plan to increase public access to health information on the Internet," Texas Medical Center News. 15 Nov 1998;20(21). http://www.tmc.edu/tmcnews/11_15_98/page_06.html)

you that [Senator] Fritz Hollings is the reason that that program got started. I mean, it's a wonderful idea. You craft all this language, but that doesn't get any kind of program put together. And then you put so many other people on it, you gotta have some money behind it. In the first year I was there, I knew perfectly well that's the year to go around and make some friends in the Congress, because you've got ignorance as your excuse. That was pretty good training.

Senator Hollings is one of the people I did go to see. I'll tell you a little bit about his very gentlemanly response to all this stuff. Well, I described what we're after and particularly emphasized IAIMS, and he listened. Visitors like me, he'd always show you his books, his collection of leather-bound books, and pictures of his libraries. He's a very charming guy, as well as a gentlemanly, kind one. But anyway, he sort of listened to my whole palaver about what we wanted to achieve with IAIMS and what would come out of it in the end, and so forth. He nodded, and then he said to me, "Yes, sir, doctor, this is all very good, but please don't let it take 12 years to get down to Charleston." So I thought, "Yes, sir, right!" Anyway, we launched the program. He, and I think it was the Joint House-Senate Compromise Committee, they were doing one of these omnibus appropriation bills, and I know that Senator Hollings stayed there till 2 a.m. to get us the—I think it was \$8 million, maybe it was four—anyway, he got at least \$4 million funded for IAIMS things. But all of that was due to a senior senator, who was subsequently a candidate for the presidency, a major guy, who had to stay there, jawboning everybody, to get us our four million bucks. Otherwise, we wouldn't have had it.

And I didn't think about that conversation for many, many years, until by golly, we got an application from University

of South Carolina. [laughter] Buzz Sawyer, I think, was the name of the librarian, a very charming guy. And happily, we funded it, and I thought of that conversation. I looked, and by God, it was 12 years! [laughs] But I felt—I didn't even tell the senator—but it wasn't that we were turning them down, it took them 12 years to get the application filed.

Most of the stuff I ever wanted to do is team research. And I began to see that one of the problems was language.

JA But again, it seems like the whole IAIMS program was so visionary.

DL It was a good one, yeah.

JA When I hear about the Regional Health Information Organizations, the buzz about all of that today, that's very IAIMS-ish.

DL Yeah, it is. Marjorie Wilson⁶⁵⁻⁶⁷ deserves a lot of

credit for that, actually.

JA And NLM does, too.

DL She doesn't get enough.

JA There are so many things on the list.

DL Well, UMLS [the Unified Medical Language System®] is a big deal.⁶⁸⁻⁷⁰ We started that pretty early. That all started with these PC e-mails and stuff like that with Hack [Harold M.] Schoolman.⁷¹ Betsy

Humphreys* was a major part of that, right from the beginning. And I've said many times, as we assembled the group to do that work, if there was one person without whom it would never have happened, that one person was surely Betsy. She was a Deputy Director for Library Operations, working under Lois Ann Colaianni.⁷²

I remember when I was sort of meeting people at NLM and deciding whether I would like to have a job or I wouldn't, I remember meeting with Lois Ann and asking her what it was she



Donald Lindberg, Terry Lierman, and Kent Smith, ca. 1985.

Personal collection of Donald A.B. and Mary M. Lindberg.

wanted. She's a very able medical librarian, a little bit set in her ways, but certainly very able. And she said to me, "Well, you know, I think that Library Operations really ought to be more a part of the research that's done at NLM." I said, "Lady, if I come here, you'll be part of it. Library Operations will be a part of the research done at NLM, I guarantee you that." And while she wasn't herself a researcher, she wanted the best for the institution, and so she was fully supportive of that idea and of Betsy's work, and it worked out quite well.

There was a little bit of an obstacle, interestingly enough. That's one of the few things I really did want to change. I mean, things that I saw that I determined I'm going to change. And that was, you know, there's two buildings: Building 38 and 38A; 38A is the Lister Hill Center, a big tall thing, and modern and research. Actually, to go between the two in the tunnel, you go by a metal detector and a guard and all that. But you might as well go by a great big conceptual thing with four-foot cap lettering that says, "HERE IS WHERE RESEARCH STARTS. DON'T ENTER HERE IF YOU'RE A MERE LIBRARIAN." I don't know that anyone wanted it to be that way, but that's the way it definitely was. I mean, "We're researchers, and you guys aren't." On the other side, "We're real, workaday library people, and those other guys are just kind of dreamers."

JA Ivory tower.

DL Ivory tower, yeah. Now, most of the stuff I ever wanted to do is team research. It always has been. And I began to see that one of the problems was language—we were going to get by the problems of getting the PCs working and getting the networks working, get

the doctors understanding, get the hospital librarians calmed down. But you still would have a problem of language. MeSH was a very good start, but there's lots of other things than MeSH, and MeSH is not meant to—medical subject headings—is not meant to encode

In retrospect, that's the only thing I really wanted to change at NLM: the idea that you separate research from service, because that's a big, big mistake.

all of medical knowledge. It's meant to index the papers that people write. So if they don't write a paper about blah-blah, then blah-blah is not in the MeSH terms. MeSH is very, very good, and it's good because the library people listen to complaints of people, and they adapt to them 300 to 400 times a year, and add new terms, and change them, and so forth. It's the best in the world, but there's more than that. Also, of course, in those days, I mean, it actually was worse than we thought, but certainly there's

no intelligence in that book, that MeSH book. If you look in the old days, you'll see that there are indents, but that's the only logic there is in it, and by the time you get to the third indent, that word doesn't know that it's at the third indent. You know, it's just a word.

And it certainly doesn't know whether it's duplicated someplace else in the book, or should be. So it's the best in the world, but it's still not very animate.

We started the UMLS [Unified Medical Language System®⁶⁸] to try to correct that. And again, it was a big project, so you have to feel your way through. We knew what we needed to get to, but we didn't know how to get there. So it was built as a distributive national experiment, where eight or nine of the best research universities were part of those contracts right from Day One. And it was built with the very active



Personal collection of Donald A.B. and Mary M. Lindberg.

Donald and Mary Lindberg visiting his cousins in Texas, ca. 1980s.

collaboration of library operations and the Lister Hill research people, and the managers. It was a team right from the very start. So, as I say, in retrospect, that's the only thing I really wanted to change at NLM: the idea that you separate research from service, because that's a big, big mistake.

Probably the biggest change that happened at NLM is [the creation of] NCBI [National Center for Biotechnology Information⁷³]. Maybe you'll have to make that a separate tape or something.

JA We're doing pretty well. Can we talk for five minutes about that?

DL Oh, sure. About NCBI?

JA NCBI, and its history.

DL Yeah. But the main thing about NCBI is NCBI is the absolute linear direct result of the long-range planning, which we started in '84 and finished in '85 and that I do take credit for in the sense it was obvious the institution had gotten along very well for 148 years, and never had a long-range plan. But it was equally obvious to me that I damned-well needed one. I had been in lots of planning, regional medical programs, and all that stuff, before. I don't know if everyone knows it or not, but to me, it's perfectly obvious: Either you plan based on the people you're trying to serve, or you just do a top-down plan, and the President or the VP or somebody just tells you, and you write it down. My experience is that the latter

We wanted to plan based on the people we're trying to serve.

things never get implemented—they get filed and shelved, and that's about it, sometimes saluted briefly.

So we wanted to do it the other way. We wanted to plan based on the people we're trying to serve, and what would be involved in it. We spent quite a bit of time deciding how many parts there'd be—would Gaul be divided into three parts, or would the world

be divided in four or five or six or seven? We ended up picking five. One of them first just contained one item, and that was toxicology and environmental health sciences, or SIS, Specialized Information Systems, because that was an existing unit at NLM. Henry

Kissman was in charge of it at the time, and it had all these chemicals and toxic properties and stuff. The format was not compatible with the MEDLINE files. That's really why they moved out of that file system to their own file system. It really was because, you know, we just have all these things that describe molecules, and then we have all this toxic stuff that didn't have a certain fixed number of fixed fields—didn't even have a variable number of variable fields. I mean, it just was its own little thing. It was a something, and I had a lot of trouble with getting it right—what would that thing be?—because it's obvious if you just say one-fifth of the whole thing is toxicology, it doesn't make any sense.

I remember consciously thinking about what would the computer scientist do? Why was there an association of computer scientists? One of their little mental flexibilities would be, when they reached



Personal collection of Donald A.B. and Mary M. Lindberg.

Donald Lindberg, Bill Raub, and Robert Windham, ca. 1985.



Personal collection of Donald A.B. and Mary M. Lindberg.

Donald Lindberg in NLM Computer Room, ca. 1985.

that point, they would go a level higher, a little more general. But this is a toxicology database, and it has all this stuff in it. What is the more general form? I thought, well, it's factual. So that particular study thing and long-range plan became factual databases. We only had one example.

And then in the course of meeting about it, of course, we presented the toxicology system as an example. It was an amazing thing. The planning group had Joshua Lederberg and also Rich Roberts, so some very, very smart people. We were doing okay, but not great, and I remember having coffee outside the Board of Regents Room, and also probably a puff on a pipe or two in those days, and I asked Alan [Levy], because I'd been on the Stanford consulting things, "What about these sequences, and the things that describe the molecules, and that database?" He said, "Oh, I know what you want. You want Molecular Biology 101 for med students." "Well, I guess so. Why don't you go do it?"

We all troop back into the place, and he literally got chalk on his sleeves, and he went to the blackboard, and he started drawing all this stuff. "Here are the nucleotides," and they make up genes. It was 20 minutes, and it was worth the entire planning process, because, I mean, even with a group that good, people were just—I mean, maybe not slack-jawed, but more or less speechless. And then we started saying, "But, man, that's a library database. That's gotta be a library project." [whistles] "Whew!" And that sketched itself out very, very quickly.

We actually took the idea to Claude Pepper, probably in violation of 67 different rules and

regulations. Mr. Pepper was in those days the oldest member of the Congress, and with some of the youngest ideas. So he connected us immediately with getting after cancer and the basic stuff in biology. He was a Harvard lawyer. He acted like a poor old country silly fellow. But his view of cancer is that it's

a monster that took his wife. So he would do anything against that. And he got behind us, so we got a piece of legislation that created an authorization for NCBI.

I recall that Dan Masys had a part in Lister Hill in those days. Well, no, he didn't. No, no, heck, he was in NCI [the National Cancer Institute]. But he was on one of these planning panels. He was the only fed that we put on. Otherwise, it was all people we were trying to serve:

scientists or librarians or doctors or something. I thought cancer was just so important that I can't not have somebody from NCBI. So I asked Vince Davita if he could possibly send someone over to represent NCI on this planning thing. And man, once I saw

Masys, I said, "Wow! We gotta get this guy!" [laughs]

JA I have two more topics I really want to cover before they make us leave the room here. One is, one of the biggest impacts, I think, on NLM that you personally have made is in the training programs. So if we could talk about that for a few minutes. And then another few minutes about the field and the development of AMIA [the American Medical Informatics Association]. Again, we could go on for hours, but if you could just capture a little bit of that—what was the genesis of the training programs?



Donald Lindberg (back) with HHS Secretary Otis Bowen, R. Wisdom, and NIH Director James Wyngaarden, ca. 1980s.

Personal collection of Donald A.B. Lindberg and National Library of Medicine

His view of cancer is that it's a monster that took his wife.

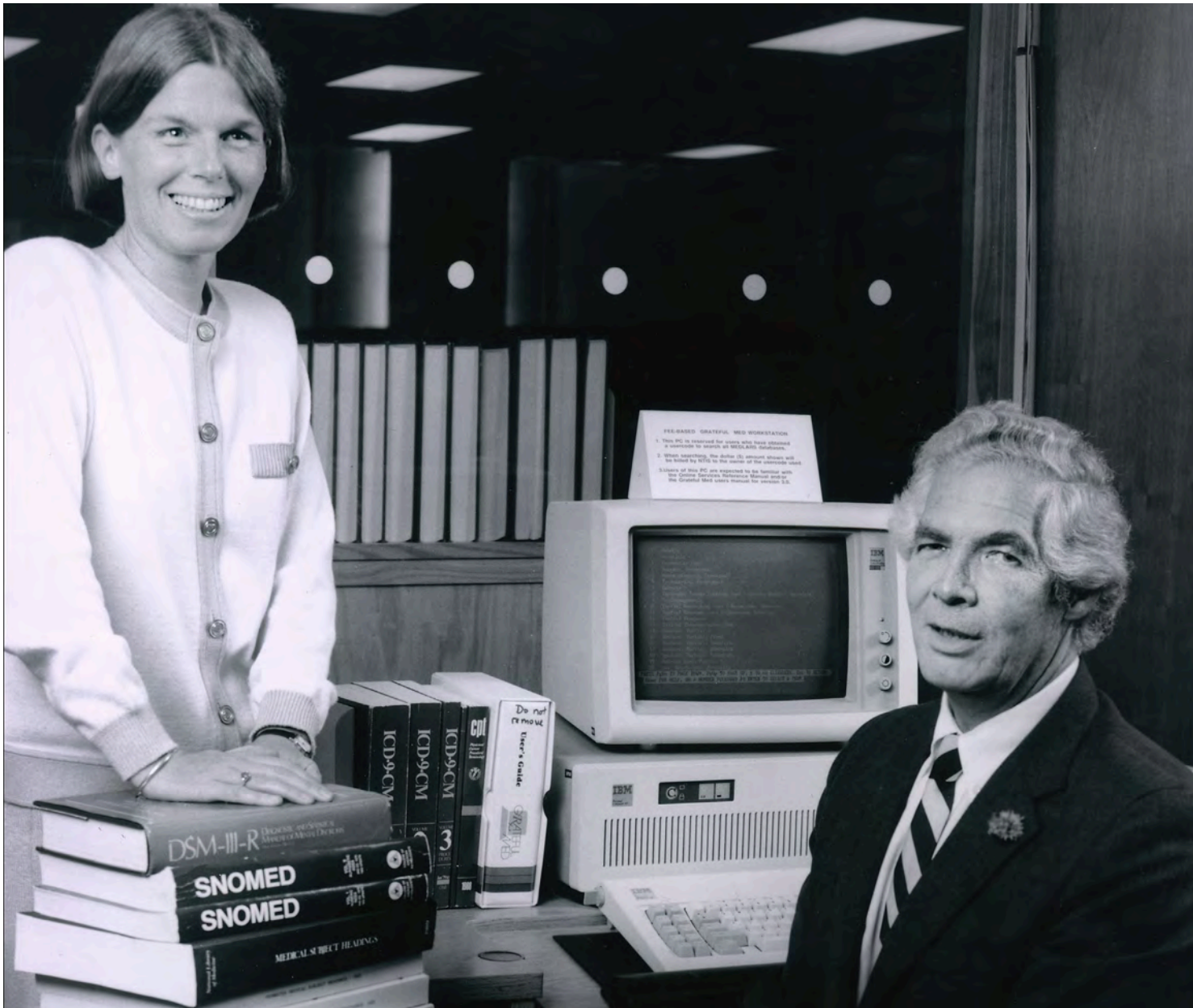
DL I don't think we're going to get too far with the agenda you just laid out.

JA *[laughs]* I'm sorry.

DL Because really, even before dealing with the training programs, we had to deal with the Regional Medical Library Program. That's something that I didn't know anything at all about till I came to NLM and was tremendously impressed by, and still am. I mean, I think that's just a marvelous development. I found we had international visitors at least once a week that were kind of looking for "what is the secret

you American folks have?" And the Regional Medical Library Program is a major part of that secret, and something that we're really proud of.

At the time I came there, it had slipped back very, very badly and had been reduced from 12 programs to 7, I think it was. They were getting cut. I mean, it looked like it was going to go under, like the next year was going to have to be cut 50 percent. So we had a lot of conversations about to what extent would it be self-sustaining without NLM money. My conclusion was, not a bit. I mean, that's just not going to work. I guess we, in a way, got lucky on funding.



Personal collection of Donald A. B. and Mary M. Lindberg and National Library of Medicine collection.

Dr. Lindberg, ca. 1989, with then-NLM Deputy Associate Director for Library Operations, Betsy Humphreys, the current NLM Acting Director. In 1990, NLM released the first version of the Unified Medical Language System (UMLS) Knowledge Sources. The regularly updated and expanded UMLS resources subsequently became integral to biomedical natural language processing and concept-based retrieval applications worldwide.

JA Tell me about the training grants.

DL I had a training grant at University of Missouri, and it was tremendously important. I mean, it was the coin of the realm, as far as I was concerned, because the training grant gave me a reason and a means of dealing with all the other clinical and basic science departments. We had people from engineering and computer science and linguistics. It was a wonderful group, and of course good fellows as well. I thought very highly of that, but I could see from the NLM point of view, overall, the things were really going to hell in a hand basket. I thought—assuming we get the money—that we ought to double both of the budgets, not in one year, but over a period of time, for the regional medical libraries and also, quickly, as quickly as possible, for the training grants.

And so I surveyed—however we do it, phone, letter, or e-mail or something—the people who were Directors of the program, saying, “If we could set an objective of doubling the number of persons in the training grants, could you in your training grant double the number? Forget about the money, but could you handle twice as many people?” And the majority said, “No, we couldn’t.” So okay, that says you have to start some new programs. That was really how that worked out. They didn’t say, “Oh, hell, yes, send the money, we’ve got people lined up outside.” So we had to start new programs. Of course, I stuck with the idea of recompeting every five years, which I think has been a good idea. It’s a little bit of an extra fuss and feathers, but there’s change at the margin. There’ll be a change in the priority list. So that was well received.

I’m very sensitive to the idea that the business of a university is education. That is not the business of a federal agency. So, I don’t like these programs like this new computer center program that’s come out of the [NIH] Road Map, where you tell everybody what’s core and what’s this and how to structure it and how to run the grants and all. I hate that. I would much rather say, “Let’s pick the universities on a competitive basis,

with proper people in the review, and then let’s express our faith in this university by letting them run the damned training program their way. They pick them, and they stand behind them.” So that means that there will necessarily be a variation in the training programs from Pacific to Atlantic, which is fine. Everybody can buy an airline ticket and go where they want.

Also, we kept them five years, to make it less disruptive. To make them longer would really get

everybody at NIH bent badly out of shape. But to make them shorter terms would mean that the universities are investing so much effort, and it wouldn’t be worth it to cut back the momentum. I can remember even when they started a training program at Stanford, I was on the study section. I was very familiar with Stanford, for all the reasons I mentioned. I was totally appalled at what rough handling they got. I mean, they had to request the damned thing about three times before they could get themselves approved. They were the self-confessed best computer science department in

the world. They were willing to plead guilty to that.

We had to let the programs, I think, do what they thought they were best at doing. But I remember when Harvard got approved—Bob Greenes was more or less the PI [Principal Investigator] of that, if I’m not mistaken—and hell, they didn’t have any applicants. We had to send them applicants from—by then, Stanford was well established, but—the other schools, which had to sort of talk it up. I mean, it takes that long till people just get used to the idea—not that they hadn’t heard of Harvard, but they didn’t know it was a training program. So all those things have a tremendous inertia and can’t be yanked around. But I’m very proud of the training programs; I think they’re wonderful. I wish we had more.

JA My final question will be about the development of AMIA. I know you were its first President, and there was a lot of activity before that. But what was it like, pulling those organizations together?

The training grant gave me a reason and a means of dealing with all the other clinical and basic science departments. We had people from engineering and computer science and linguistics.

DL Well, it was perfectly obvious to most people it had to happen. But it was a question of how much yanking around to do. I mean, I was on the SCAMC [Symposium on Computer Applications in Medical Care] board. I was the first person on the SCAMC board who was not a Washingtonian. I don't remember who it was that proposed me—probably Tom Piemme, I suppose, I don't know. I remember meeting with the board, and they wanted assurance, first of all, that I would pay my own way to board meetings. I said, "Well, I'm in Washington as much as I want to be. I can certainly pay my own way, that's not a problem." So it was really down to that. They used to have kind of really trivial meetings. It wasn't a good organization at all, in my opinion. Tom did a wonderful job of managing meetings, but they would have discussions about whether they would cover people's parking

expenses, and why was somebody in a hotel and somebody not. I mean, it was really kind of petty.

JA That was pre-AMIA [American Medical Informatics Association], and then founding AMIA, how did that happen?

DL Well, there were really three organizations. You know, I'm embarrassed to say that I've forgotten the name of the one that Marion Ball was actually President of. Rudy Bickel and then Marion were President of a professional computer organization. But, you know, [I thought] the organizations obviously should blend together. And then there was ACMI [American College of Medical Informatics]. ACMI had already been created as a separate organization. There was actually one bloody night of discussions of all this and a vote that was fairly conclusive to say, "Do it." At least one very senior guy in the group

Personal collection of Donald A.B. and Mary M. Lindberg and National Library of Medicine collection.



Mrs. Alice Fordyce of the Lasker Foundation with Dr. Lindberg, ca. 1990.

just stood up—he had his say, and they voted against him—and he stood up and essentially said, “I’ll never speak to you guys again in my life,” and walked out and that was it.

JA That’s the bloody night?

DL Yeah. I voted for it, certainly, myself. Perhaps the most outspoken of all, in favor of the fusion, was Octo Barnett.* But I think, if I’m not mistaken, that Rudy Bickel and Marion Ball were head of, maybe just ahead of me, or past that, of one of these organizations. One of them, Ted Shortliffe, had been elected the new President of one of these organizations, and he said, “I couldn’t care less about that. You should definitely form this thing.”

⁷⁴ So it was difficult, it was bloody, and there were compromises, almost like the Congress. For instance, if you are a member of this wonderful board, like the SCAMC [Symposium on Computer Applications in Medical Care] board, then you’ll get admitted free to AMIA for the rest of your natural or unnatural life. Okay, fine, just do it, that’s great. Just do it—buy their votes, do it.

JA Okay, I do have one last question, then we can go to lunch. If you had one word of advice to offer future informaticians, what would that be?

DL Hm. Well, I mean, I don’t know if it’s a trick question, but I remember that I agreed to be—what the heck was that called?—kind of in charge of organizing a MedInfo ’84. I’ve forgotten now. It

wasn’t a chief to pick the scientific papers, it was like a general manager or something like that—I don’t know, chairman maybe. One of the reasons for doing the MedInfo in Washington is that a number of us had been—I guess it was 1980 in Tokyo—where they did a fantastically good job—really, really good job. Intervening was Holland in ’83, but Tokyo was really everybody’s model. We were determined—I was determined, Morrie Collen* was a big part of it as well, and others, certainly Homer Warner* was behind it, Mike Ackerman—and just decided on the way back from Tokyo, “Let’s get this thing in the U.S. and let’s set our goal to do as well as the Japanese have done.” So ultimately, there was a lot of maneuvering to get an organization put together to fund it, because of course in Japan, the government just funds it, and then in Holland, the same way. We don’t work that way, so you have to make a whole organization for that, that I could tell you about. But in any case, I went back to see the guy who had been that chairman kind of person for MedInfo in ’80 in Tokyo, and asked him about advice. “What advice can you tell me to put this whole thing together?” And he said, “Keep us smiling!” [laughter]

JA And that sounds like really good advice.

DL That was not bad advice.

JA I’m going to close now. Thank you so much.

DL Okay, thanks.



Personal collection of Donald A.B. Lindberg and National Library of Medicine collection.

Celebrating Women’s History Month at the U.S. Capitol, ca. 1995, are (L-R) Dr. Lindberg, Frances Humphrey Howard (who was Special Assistant to the NLM Associate Director of Extramural Programs), former Congresswoman Connie Morella (R-MD), Bill Raub (who was then Science Advisor to the HHS Secretary), and David Nash (NLM Education and Outreach Liaison).



Personal collection of Donald A.B. Lindberg and National Library of Medicine collection.

Dr. Henry Lewis III, then Dean of Florida A&M University and later member of the NLM Board of Regents, with Dr. Lindberg, ca. 1995.

JA This is Joan Ash and Dean Sittig interviewing Dr. Don Lindberg in the Board of Regents Room at the National Library of Medicine. It's July 13, 2005.

DL One of my fondest desires was to get Josh Lederberg to give his personal scientific papers to NLM, be part of the history of medicine [in Profiles in Science®]. So Alexa McCray and I started a project to essentially do history of medicine in a new way. You need a test case, and our test case was Regional Medical Program activities. Because we had had a conference on that, a lot of people had already given materials to us. Of course, that all happened back in 1965, roughly. So we just played around with how would you enliven this, and how would you, for instance, even get notations [metadata] on some of the materials, even that a person himself or herself had given the material to us, but what detail to include we didn't fully understand.

We did sort of teller notation, if you will. Buck Rikli, for instance, was one of the guys who agreed to this—again, an old guy with young ideas—and we said, “Look, Buck, we'll figure out how to do this. We'll get images to you, we'll each have a stack of them or something, and you'll annotate them so we understand what the hell they're all about. He got into it and liked it. So we did that with a number of

other people, and we figured out how to scan in stuff. Again, you can say “simple,” but there wasn't any commercial software to buy to do it. We wanted to scan [the pages] decently so you could OCR [optical character recognition] it and so forth.

Essentially, we began to deal with the problem that if you go back not very far in modern 20th-century history, you find that people are doing letters on these hectographs. You know, I turn this thing, and it comes out purple print. I mean, I used to do that as a job for people, turn the thing. And they fade. They're never any damned good to begin with, and after 45 or 55 years, they're poor. The really high-class stuff, you have CC, carbon copy. Okay, yeah, but you can have eight pieces of paper, with carbons between them, and one of those [stamps hand on table three times], and you don't get too good a copy at the back. If you make a mistake, as you know, if you saw something wrong, you had to look your poor secretary in the eye and say, “Let's scratch all this stuff out.” And this is on eight copies. A lot of things went out that shouldn't have gone out, I think, in everybody's correspondence. That's why everyone loves word processors so much now.

But anyway, we began to accumulate [these ideas about preservation] from all of the people who were part of the Regional Medical Program. We essentially



Personal collection of Don E. Detmer.

Jean-Raoul Sherrer, Mary Lindberg, Mary Helen Detmer, Don Detmer, and Donald Lindberg, Geneva, 1995.

learned how to deal with the stuff. How good did you have to be, and what was possible and what wasn't? When we finally got it all done, I had an occasion to say to Josh—it probably was a social occasion, I suppose, I don't know—"Josh, we've been doin' this work, and we've been inventing a new way to do history of medicine. We are really doing it because—you know, I wanted to ask you to give your papers, and I'm sorry, it took too long, and now it's too late." He said, "It's not too late." So I really felt good about that, and then we started. We'll probably never do—well, there'll never be another Lederberg—but we'll never do a collection as big as this again. I mean, I knew roughly what I was getting into. The day that Alexa and Josh and I were sitting in my office, and there was some beef in history of medicine, and there was uncertainty whether we were talking about meters or feet. I knew this was going to be a big one. [laughs]



Skipper Don Lindberg and "our" Marys (Mary Lindberg and Mary Helen Detmer) on the Potomac, ca. 1990s. Photographer Don Detmer.

JA We're trying to get ahold of the oral history transcript of the Nina Matheson interview that the Medical Library Association had done,⁷⁵ which is why we have our approach now. It said 20 linear feet of boxes.

DS Boxes her transcript is in somewhere—they haven't quite finished processing yet.

JA It's in Baltimore, I guess we discovered. That's why I wanted to ask you if you had any ideas about what we should be doing with this.

DL I guess I was too long-winded, that's the bottom line, the whole point of it. So when we switched to Lederberg, Lederberg got totally into the thing. I thought he just agreed, "No it's not too late, I'll be glad to give you—." And that was it. We'll send people up to Rockefeller, and we'll start boxing stuff and bring it down. The only bad part was he said, "I'm going to do this. In fact, I'm glad to do it, because people keep telling me I've got to write an

autobiography, and I don't want to write the goddam autobiography. So I'm going to take that amount of time, that amount of energy, I'm going to put it into whatever you say to do that'll increase the value of this for other people, because people tell me they want to do biographies," So we'll never have a Lederberg autobiography, which is, I think, a loss.

But he put a tremendous amount of effort into helping us choose the index terms, helping us

interpret—here is the thing, but you probably don't know why it's there—that type of thing. Plus, of course, there's a couple of wives and other people who are still alive, and not dead for the statutory number of years, and so it has to be that kind of sorting out. And then I guess none of us connected with it, had encountered some of the questions, like, well, okay, here's this correspondence between me and "A," so I'm going to give it in, because I guess I own it,

but do I really own it? What about the other person?

DS Someone else might have written it.

DL Well, what about the rights of the other person? We had to work through and think through all that kind of stuff. So it was done. But that was a very, very big task. It's very well done, but—. Oh! I know, we got about a third of the way through when I got a call from him that made me just feel good about it, that it was a real success. It was in the middle of summer some year, and Lederberg was calling from New York, and he said, "You know, Don, I finally reached the point where I can honestly say there is just no point in my keeping originals of any of this stuff, because it is more useful to me, with the computer you've given me, and the line you've given me, when the stuff is in NLM, than if it's in my file someplace." That was what we were after to begin with. That's exactly, precisely, what we were after. So, I mean, there is that to consider about sort of a modern way to do history

Photographer Don E. Detmer. Personal collection of Don E. Detmer.

of medicine, if you will—if you’ve got somebody that willing, that able.

JA Well, there were a few things I wanted to pick up on from the last time. As we’ve been going over the transcript, there were some untold stories.

You told a NCR [No Carbon Required] paper story that you had told at Woods Hole. I had asked you to tell it on the tape again. But there was another one that you told at Woods Hole that really caught my interest. I only vaguely remember it, but you were at a hospital, and you needed a record, and you needed it from the hospital across the street, and it had snow in the story.

DL Oh, yeah. I was at a major medical affiliation at Columbia Presbyterian. How can I forget the name of the place?!

JA So it was in New York.

DL In New York, yeah. Roosevelt was sort of the surgical one. This was more medical. It’s probably Saint somebody. At the moment, the name of the hospital has gone out of my head. But it was a good place, and I had a patient there who had been treated a few years before at another New York Hospital, which I think was Lennox Hill, maybe—though I’m not certain of that one at this point, but a local hospital. So I called them to say, “Your former patient, Miss So-and-So, is now under my care at this place, and so we’d like to get hold of the old records so we can find out what was going on with her.”^{49,76} And they said, “I probably can’t do that, because of where it’s stored.” I was just hanging out, walking around, and I was thinking, “I’m up in this big tall building; I can see the hospital over

To me, it’s an argument for the patient having the records to begin with.

there. I can see it!” So I said, “What’s the problem? Is it off site? Can we buy you a taxi cab or something, and the medical records people will get it for us?” “Well, no,” they said, “it’s actually all safely stored, but it’s stored up on the roof.” I was looking, and I said, “Yeah, I can see the roof. There’s a funny kind of building up there.” And they said, “And you’ll notice that it’s all covered with snow. So when the spring comes, we’ll go get it for you.” [laughter]

DS And we’re worried about these disk access times on our computers.

DL Yeah. To me, it’s an argument for the patient having the records to begin with. I can’t imagine why we’re delaying on this. I mean, there was a very well-reasoned article—I think it was ’62, might even have been ’52, but it was probably ’62, in New England Journal [of Medicine], where a guy put forward a very carefully reasoned argument for “here are all the

reasons why it would be much, much, much better if a patient had a copy of his or her record.” There was a certain amount of discussion about it; certainly 99.99% of the people were totally opposed to it, terrible idea, awful. And there were no, so far as I can remember, sort of patient groups. I mean, I guess there must have been a Cancer Society and Heart Society and something like that, polio or something—March of Dimes, I guess. But they never stepped up and said anything about stuff like that. I mean, they shook hands and got dimes and that kind of thing. I don’t remember any voice of the patient, of any sort.

DS Times have changed a little bit.

JA Well, they’re on their way, I mean, with that one.



Local news anchor Jim Vance after giving a talk at NLM, ca. 1987, shaking hands with Dr. Lindberg, while Dr. Donald Buckner (then-LHNCBC Special Assistant and NLM EEO Chairman) looks on.

Personal collection of Donald A. B. and Mary M. Lindberg and National Library of Medicine collection.

DL Well, even at NIH, there's a thing called COPR, (pronounced "copper"), Council of—P-R—but it's not public relations. It's more like "patient representatives" or something like that—"public representatives"—that's probably it. But there was a time when NIH—I've forgotten why we were in trouble, NIH was always in trouble over some damned thing. And so the Congress asked the IOM [Institute of Medicine] to study whatever problem it was. They came back with a typically pretty well-balanced, nice report, but one of the things they said that [NIH Director] Harold Varmus somewhat took amiss

was that as far as they could see, everything was in great shape, except [before the NIH Council of Public Representatives⁷⁷⁻⁷⁹ was created] there was no way for these patient groups to have any input or advice or comment or knowledge, even, about how NIH was really managed, and they were important considerations and so forth. So he decided the better course of valor was, "Go ahead, do it. Just do it, do it, do it. And we'll put up with that, too."

It quickly turned out that this COPR has got incredibly good people on it. The sessions are the most interesting sessions. I mean, there's a director's advisory committee, which is mostly scientists and deans and the great men and women of the world. I sometimes go to those meetings, but I always go to the COPR thing—a very interesting bunch. Almost everybody feels that, "Gee, we should have done this a long time ago." And there's a long list of people that

willingly join it. You don't have to beg and plead. So, yeah, times have changed—gradually.

JA I forgot to ask you the last time about your role in high-performance computing. I completely skipped over it, and I wondered if you'd just say a few words about that effort.



Dr. Leon S. McGoogan and Dr. Lindberg shaking hands, ca. 1990s. Dr. McGoogan was an Omaha obstetrician and faculty member of the University of Nebraska College of Medicine. The UNMC Medical Library was named in his honor.

Personal collection of Donald A.B. and Mary M. Lindberg and National Library of Medicine collection.

Before the NIH Council of Public Representatives was created there was no way for these patient groups to have any input or advice or knowledge, even, about how NIH was really managed.

Senior, as I recall. His view of the matter was, as far as I could tell from his public statements, that we're having trouble. The Canadians say we're shipping up acid rain, and the other people say that somebody else is shipping bad stuff to us, and everything's going sour. But there are disputes about it, so it sounds like it's a scientific question. You have a scientific investigation, you get a scientific opinion on it, and the government pays lots of scientists—for God's sake, get a study going! But the agencies involved in it were largely, I guess, what they thought was relevant—I mean, the DOE [Department of Energy] and those kind of people—so they began to do the study.

I was struck when I saw the appointments and the commissions and what they were doing that there was no health input at all. I mean, it was like we're saving the world for the cabbages or something. What the hell about the people?! It was astounding to me. There

was no talk of genetics or mutation or anything—evolution. Wasn't there at all. It was all strictly acid rain, and is the Antarctic shrinking or getting bigger? You know, the condition of the ice cubes and all that. So I told myself that if this merry-go-round came around another time, studying something of relevance, I was going to make sure that health was part of it, that people were in the equation.⁸⁰ So that was why, I guess, I was sort of ready for this thing to happen. But I didn't really understand quite what was going on. Anyway, Gore and others produced legislation, created the need for a high-performance computer, and later it was to include a communications program. But again, there were lots of hearings about it, just as there have been lots of hearings and testimony and stuff about the [Human] Genome Project before it got going. Dan [Masys] did some of it, and I did some of it. And so we were kind of semi-involved.

One day I got a call that said, "We want you down at the White House mess at lunchtime today." And I went across the hall to Smith's office, and I said,

"Smith, what the hell have you done?! They're hauling me down to the goddam White House!" [laughter] Because, I mean, we're always kind of skating on a little bit of thin ice. We weren't really sure which way the breaks had occurred. He understood the question, he's revealing for me all the various dealings. We just couldn't identify what was so egregious that I was going to be banned or something.

So I went down, and I had lunch with Gene Wong, and about halfway through it, he said, "You know, there's this high-performance computer and communication proposition, and we are convinced by what you've said, that there should be a health component, and we'd like you to chair it."^{11,12} The whole goddam thing! Organize it, do it. I was astounded. I was prepared—

JA For the worst.

DL Yeah. So I said, "Okay, I'll do it." Actually, I said, "Let's go see Bromley," because Bromley was actually a science advisor—Allan Bromley. And he was persuasive also. Then I came back and said to Gene Wong, "I think I'm going to be willing to do it, personally. I think I really ought to talk to the folks I work with and for at NIH." The Director of NIH was Bernadine Healy. She had been in OSTP [Office of Science and Technology Policy, in the Executive Office of the President] in an earlier career. I immediately went to her—I liked her very much—and said, "Here's what they're wanting me to do. What do you advise?" She said, "Oh, Don, absolutely do

it. It's going to be great, you'll enjoy it, you'll do it better than anybody else." When she wanted to be nice, she certainly could be very nice. I said, "Well, anything further?" And she said, "Yeah, I'll give you something further. You do not want to live down in that Executive Office Building. So if you can possibly do it"—and I was hoping she would say that, too—"base yourself at NIH. Go down [to Washington, DC] as required."

That turned out to be very, very good advice, because the accommodations are awful. I mean, an office in the White House, like everybody whose name you can name, had an office below ground 11 feet across. Terrible facilities. The Executive Office Building is somewhat better, but not a lot, and it's hell to get anybody in and out. The security is totally miserable. In those days, they were bitterly afraid of any phone call that wasn't on a wire that you could see. They didn't like modems. They were really running scared. So that would have been completely awful. It turned out amazingly well. In order to get the thing out here, I knew there was no point in asking Bernadine or anybody else, "Would you please come up with the space to house this?" I knew damned well I'd have to take it out of NLM someplace. So, we developed the space, basically, down on B1 [in the basement of Building 38A], in sort of a big hurry, and a lot of people helped us.



NIH Director Harold Varmus and former NIH Director Bernadine Healy at her portrait unveiling, on August 1, 1993.

Profiles in Science: Harold Varmus Papers. <http://profiles.nlm.nih.gov/NV>

It ended up being a very, very good facility. It turned out that there had been lots and lots of meetings with the different agencies—you know there were nine agencies, and it ultimately ended up being fourteen. So most of the meetings would be in some downtown place, or in the Pentagon. The Pentagon's even worse to get in and out of. So I said, "Well, if I'm going to do this, we're going to meet out here. Let's try it, anyway, let's see how it goes." It turned out that if you set those meetings up at like three o'clock or four o'clock or 2:30 even, on an afternoon in Bethesda, man, they flocked here! They all live out here in Montgomery County. It was great! I mean, you're halfway home. Sure, we had no problem whatsoever on attendance. And the other, I thought, secret of it all was that you throw in some cake and cookies and coffee and juice—. Our NSF guy only wanted a banana.

DS *Wouldn't have a cookie, huh?*

DL Well, I think he was both eating kosher and also a diabetic, but somehow the banana was okay. But anyway, it was great. It was absolutely great participation, and they loved it for the reason I said.

JA *How long did that project go on?*

DL Less than four years. I agreed to do it a year or two, because basically I was simultaneously—well, I also wasn't going to give up NLM. So I know I did it for two years. Well, of course then there was a change in the presidency, so we'd have to go back and look. In this case, the Republicans were voted out. That was the senior Bush's last, and then Mr. Clinton was voted in. So I, of course, dutifully trailed down there [to the White House], and turned in my resignation. "Thank you very much, it's been wonderful." And they said, "Oh, no, no, you've got to see us through," and all that. I'd been sort of a Democrat all my life, so I wasn't ready to quit, just on the grounds that you can't do a good job on two jobs. Certainly, Gore had

helped enormously, and he was going to be supporting it fully—because he was supporting it really fully even when his party wasn't in the majority.

I must say, all this nonsense about Gore saying he'd invented the Internet is baloney. He never said such a thing. I will say about him that I never, ever asked him to do something for that high-performance computer program that he didn't do—whether it was show up or have a thing in his office or send a memo, or knock somebody on the head to clear the way. He never failed. Well, we didn't overuse it, of course, either. But he never failed to be supportive and helpful. So I think we really do owe him a lot for understanding, or

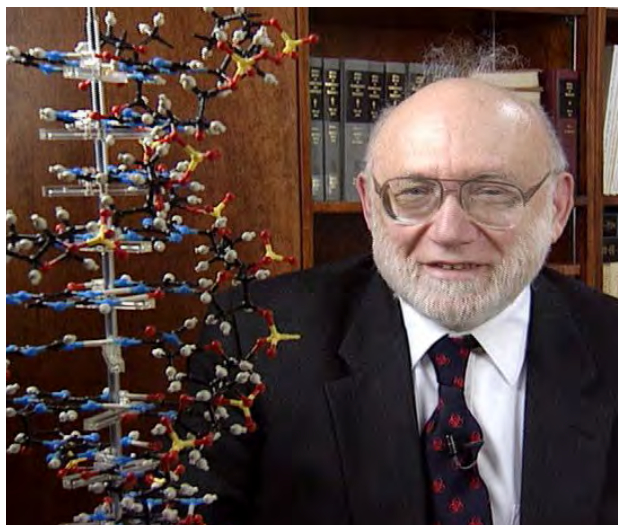
appreciating, anyway, the technology.

JA *So how do you feel about that experience?*

DL I liked it very much. I thought it was very worthwhile. Bernadine was quite right. There's sort of good and bad. But one of the things I learned right away that I found very enjoyable was that there are excellent people in all these departments. I mean, there were people you could personally and

professionally admire. Of course being in different scientific fields and different agencies and different missions and so forth, they're going to have a different slant from you, but that's sort of the fun. I found no difficulty at all finding lots of excellent people to admire in federal service, so it made me feel good about that.

The other thing that quickly became apparent is that these interagency activities have incredibly high overhead, even in universities, stuff between schools, and even departments. But at an agency level, it's very high overhead, for just lots of different reasons, one of which is their fiscal process goes on a different schedule. Well, you see that in universities, too—there's nine-month people and twelve-month people. But one of the key things about that activity was preparing the President's budget for this high-



Dr. Lederberg with model of DNA, March 22, 1996.

Profiles in Science: The Joshua Lederberg Papers Collection (<http://profiles.nlm.nih.gov/BB>), courtesy of American Society for Microbiology.

performance computer communication thing. One curious thing there was to find myself, the only time in my life, on the same side of the table with OMB [Office of Management and Budget], because OMB's job was to go around and be mean to NIH half of the time. But their job was to support the President's program. So, if the high-performance computer program is a presidential program, a cross-cutting effort, goddam it, they're on your side, making sure that the agencies are doing what they're supposed to be doing. So that was fun.

JA I'm not sure that I understand what you mean by "overhead." Do you mean like indirect costs?

DL No, waste of time. The amount of time it takes to meet with all those people, and write documents. Take the position paper. You know, like, "What is it we want to say about so-and-so?" Well, okay, here's 14 agencies, so you could have a committee of a thousand, if you wanted—obviously, you don't. So generally speaking, it works always the same in all settings. I mean, you'll get a writing committee of three, four, five people chosen to actually be workers, who have some ability to write, and the others trust them. Then it goes back to some larger group, and there'll be some modifications or votes, or whatever necessary.

But that's a lot of time and effort, and what interested me is that at least in those days, there were people that were really very able in high-performance computing. They were like NSA [National Security Agency]. I don't know if you've ever seen that place, but there's enough electricity running NSA to run a fair-sized city. So there wasn't any question they knew computing, but if it came down to, okay, how about some software to help us collaborate? You know, group tools, so-called? "Oh! No problem at all." "Wait a minute, I've got a big problem. What are you talking about?" Well, there are contractors. DOE's [Department of Energy's] contractors, for example. I think it's just about as bad now.

Much as I dislike Microsoft Word, it's a lot better than it was then. But you still had versionitis. You wrote it on nine [Version 9.0], and I only have eight [Version 8.0], so I can't read it. So multiply that by the different platforms, plus 14 agencies, and the Internet wasn't invented yet. I mean, it wasn't in broad civilian use. I mean, I used ARPANET [Advanced Research Projects Agency Network]. Getting that stuff done, it's still a pain in the neck. But it was a big pain in the neck. It was even technically a big pain in the neck—and particularly if I want to include equations. That's why the Stanford guy, Don Knuth, made a whole system—called TeX—so he could do equations.



In 1996, US Senator Bill Frist (R-TN), himself a physician, and pioneering heart surgeon Dr. Michael DeBakey joined Dr. Lindberg at a press conference to conduct the first internet search of MEDLINE, NLM's premier database of medical citations. There were 8 million citations in MEDLINE in 1996. Today, there are more than 24 million.



Claude Pepper, former US Senator and Representative (D-FL), talks with Dr. Lindberg, National Center for Biotechnology Information (NCBI) Director Dr. David Lipman (center) and Frances H. Howard (background) at a Capitol Hill reception following the passage of Pepper's bill creating NCBI, October 3, 1998.

JA I have to ask you about another thing that you mentioned in the last interview. We had talked about when you first came to the National Library of Medicine and the hospital librarians were upset—you ungrateful man. [laughter] I remember that, having been a librarian at the time. And, you know, we're doing research on the unintended consequences of technology right now, but I wonder what other kind of unintended consequences and surprises you may have experienced like that in your career at NLM.

DL Well, there was no surprise. We knew perfectly well what was going to happen.

JA Oh, you did?

DL Oh, of course. Since my conviction was that it was going to help everybody, including them, and make their field more prominent and their jobs more enjoyable, and their users happier, I just kept saying it. But they just felt threatened job-wise. The university library people didn't, but the hospital people felt that what they had for sale was the ability to say the right abracadabras and call up a reference. Actually, they had a lot more to offer than that.

I don't know if it made many converts with the metaphor, but to me, it was like people who have had some musical training being the ones that really appreciate the symphony and the opera. Or if you're really a pretty decent amateur photographer, which



On June 26, 1997, Vice President Al Gore performed the inaugural search opening up free access to MEDLINE on the World Wide Web, via PubMed. Gore (seated) joined (left to right) MEDLINE user Suzanne McInerney, NCBI Director Dr. David Lipman, NIH Director Dr. Harold Varmus, and NLM Director Dr. Donald Lindberg at a Capitol Hill event hosted by US Senators Tom Harkin (D-IA) and Arlen Specter (R-PA). Harkin said, "Today, ER meets the Internet." Specter noted that, with the advent of free MEDLINE, "The superhighway of medical information just became a freeway." Lindberg said, "Citizens are increasingly turning to the Web as a source of information to improve their daily lives, including their health. So it is vital that they, and the health professionals who serve them, have access to the most current and credible medical information." (Modlin M. Info Superhighway Becomes Freeway: Vice President Gore Launches Free Access to NLM's MEDLINE. [Internet]. NIH Rec.1997 [cited 2015 Mar 20]; Available from: http://nihrecord.nih.gov/newsletters/07_15_97/story02.htm)

Personal collection of Donald A.B. and Mary M. Lindberg.

I think I'm going to claim, but then you really can appreciate Ansel Adams and the other greats—much more so than if you just look at a picture and say, "Nice picture." You know what he went through to get it and make it and so forth. So I said, "That's the way it's going to be with this literature referencing. You're going to end up with the end user people, the doctors

and the scientists; they'll do the easy stuff. But there's plenty of hard stuff. That's what you guys are for. They'll bring all that stuff to you, and the demand for medical librarians is going to be times 10 and times 20."

One of the people really selling them Confederate currency was this funny old library guy—I think it was in Indiana, maybe—really a complete jerk of a fellow. He kept pumping them up by putting out articles about how terrible this was going to be. Ultimately, MLA [Medical Library Association] organized a debate—I was called upon to debate this old fool. He used the phrase that I really love, because I kept returning to that—"Lindberg will make you hewers of wood and drawers of

water."

Quickly, [my arrival] was translated into sort of public policy issues, and how vulnerable NLM was. I mean, I actually didn't come here to change anything. I love the place. I sort of imagined myself, if I had to imagine it explicitly, sort of coming out on the bridge

[of the ship] once a day and looking at the horizon to make sure it was still horizontal and saying, “Mr. Smith, take it a half point to starboard.” Sort of a Queen Mary, in other words, majestically continuing for this 150-year progress. I discovered that it was more like Route 270 in rush hour. I mean, you just didn’t dare take your eyes off the road. You definitely didn’t just go off, go away and forget about that.

Well, opportunities good and bad would arise virtually daily, certainly a couple of times a week, and we never knew which direction they were coming from. I remember Schoolman, when I came down, was sort of describing things, like Washington and so forth, and I actually knew Washington pretty well. Mary grew up in Chevy Chase [in Maryland]. So he said, “Like, for instance, August. In August, nothing

happens. Usually July, but July and August, it’s just laid back.” And I thought of it many times, because now we’re busy as hell in the summer! All kinds of stuff going on. So I guess it was different in sort of olden times, maybe.

JA What were some of the biggest things that came down the pike that surprised you, where you had to “drive fast”?

DL Well, I mean the debates with the publishers were, of course, still going strong when I arrived.⁶⁰ We always knew that, basically, Elsevier was behind a good bit of it, but Williams and Wilkins were actually operating the suits against NLM. So that was still pooping along.



Personal collection of Donald A.B. and Mary M. Lindberg and National Library of Medicine collection.

US Senator Tom Harkin (D-IA) used the newly-launched NIHSeniorHealth.gov, a Web site with special features tailored to the needs of older people, developed by the National Institute on Aging (NIA) and the National Library of Medicine (NLM). Joining Sen. Harkin at the Capitol Hill event are (left to right) NIA Director Dr. Richard J. Hodes, NLM Director Dr. Donald A.B. Lindberg, and NLM’s Joyce Backus, who was Lead Systems Librarian in 2003 and is currently the Associate Director for Library Operations.

DS *Were these suits about who owned the abstracts—is that what they were?*

DL Well, they were trying to forbid us access to the abstracts, yeah.

DS *Even the abstracts?*

DL Yeah. Oh, yeah. I mean, they were really hacked off because we did go to courts, and the courts judged on the side of NLM. I mean, they continued to say, well, they were badly instructed and erred in their duties, and all this kind of stuff. No, they gave up hard—stupid, really. We're like a giant advertising agency, for publishers. I don't understand them.

It's like a Sears Roebuck catalog is mean to the people making the equipment? I mean, that's ridiculous. They didn't get it. But, you know, there were lots of surprises. I remember I was surprised when I saw that everybody up here had Wang word processors. Yeah! Terrible choice.

DS *Tell us a little bit about PubMed. You know, it just seemed like PubMed came on us so fast. I didn't have any idea it was coming, and then all of a sudden, it was just everywhere. Was that a backroom project you'd been working on?*

DL Well, not exactly. What I inherited was ELHILL. ELHILL, of course, is Lister Hill. But ELHILL, for practical purposes, by the time I arrived, was like 175 PL-1 programs, interacting PL-1 programs, all of which were batch, but

were converted to run online. You know the kind of situation I'm talking about. The universities all had similar kinds of messes, but this was a pretty big mess. But it worked, it did work—it did the job. It did a lot

of jobs. But you didn't recompile a lot of this stuff, because it was patched to the patches. So if you started putting in new stuff, you just couldn't recompile them.

Worse than that, the so-called—we didn't have the term "GUI [graphical user interface]"—but the interface that the so-called user would see used to require six weeks of training librarians how to cast up these screwy instructions. So it was perfectly obvious, at

least to me, that was a good system, but it should talk to other programs, not [directly] to people. And also, the question arose—Schoolman and I discussed that very explicitly on a number of occasions—did

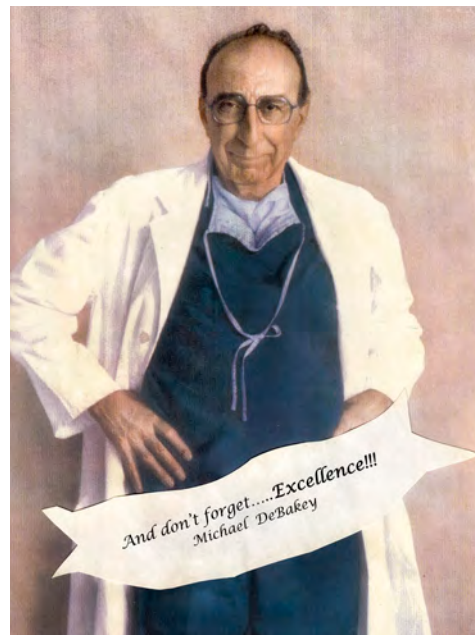
I know how to rewrite it?

Well, yeah, sure. I mean, I'd done that kind of stuff at Missouri. But I decided I just am not going to burn out five more years of my beautiful young life redoing that kind of crap—just not going to do it. When it runs, and there are people here that know how to run it, what it needs is the front end. So that's what Grateful Med became—very, very well done, actually, by a guy, Davis McCarn, who had been an NLM'er and then he either retired or left somewhat prematurely, and he started his own company and so forth. Very clever guy. He became our contractor, and he did most of that.



NLM Director Donald Lindberg and Michael DeBakey, celebrating DeBakey's 90th birthday with the gift of a brick from the Army Medical Library building, previous home of the National Library of Medicine.

Profiles in Science, The Michael E. DeBakey Papers Collection (<http://profiles.nlm.nih.gov/FJ>), courtesy of Karlon Jackson and the National Institutes of Health.



Michael E. DeBakey in his surgical scrubs, ca. 1980. Dr. Lindberg's framed photo includes Dr. DeBakey's reminder, "And don't forget.... Excellence!!!"

Personal collection of Donald A.B. and Mary M. Lindberg. Original photo also available from Profiles in Science, The Michael E. DeBakey Papers Collection (<http://profiles.nlm.nih.gov/FJ>), courtesy of Aaron Shikler and Mel Reingold.

I asked Rosemarie Woodsmall to set up sort of the testing group, which, amazingly enough, they never had. They just wrote stuff and put it out, and that was it. And then there was ELHILL: “Well, give us six weeks, we’ll teach you how to use it.” It’s not what we want. I want doctors using this damned thing. So we’ve got to have lots of feedback and a means to get the people’s honest responses. Anyway, she organized all that. But we were enormously proud of version one. I mean, of course, when you come back to one of these things a few years later, you think, “Oh, my God, this was childishly simple.” But it was very gratifying.

DS I guess there was an Internet Grateful Med, too, for a while.

DL Yes.

DS Before the Pub Med.

DL Yeah. But see, all the while we had to get rid of this ELHILL thing. ELHILL is like the “elephant in the room,” as they say. More and more people would retire or die, who knew the care and feeding of it. So there were certain things that we really had to do. It dragged on to the point where it was one of the things we had to do with this goddam Year 2000 [Y2K] panic. It turned out that there’s a

wonderful programmer systems guy, David [Kenton], who is and was in OCCS [Office of Computer and Communications Systems]. He knew it in great detail, and he had one chum in the world that knew it equally well, and that’s a similar guy in London, where our British center was. So anything major you wanted to get done, first of all, had to be in the summer—that was the way they worked. Actually, the British guys would let them off. They had to work together in one of those two places. You could pretty well guarantee that they would bring back the changes, and they were to be checked out, and ensure the whole 175 things would interact appropriately and so forth. So obviously there’s that problem.

There was a big push in the government—ill-conceived in my view—but anyway, essentially, to deliberately be

mean to IBM—to deliberately make it difficult for IBM shops to exist in the federal government. A Texas congressman just made that his business. His name escapes me at the moment, too. He caused us lots of grief.

So that was hovering over us. It was dumb. But our stuff, for sure, would only run on IBM machines. I loved the whole system, so that it should expand,



National Library of Medicine collection.

Input typing for Medlars.



National Library of Medicine collection.

Dr. Mary Corning, former head of NLM International Programs with Dr. Joseph Leiter, former NLM Associate Director of Library Operations, ca. 1983, (left), Lois Ann Colaianni, former NLM Associate Director of Library Operations, and Dr. Martin M. Cummings, former NLM Director.



National Library of Medicine collection.

to me, was a natural thing. We probably discussed expanding beyond operating just eight hours a day [so our services would be available during business hours in other time zones]?

DS Right.

DL Well, then, the other thing was Russia and China. It doesn't take much imagination to remember Russia and China. We had had lots and lots of correspondence with the Russians during the Soviet Union period—no progress at all, except just bad language back and forth. So there was going to be one last meeting, and I didn't see any reason in the world we shouldn't have a library association in Moscow. I mean, the earthquake people and the weather people continued throughout the whole Cold War to exchange data for 45 years. Even in those days, we can go back 45 years on weather data out of Eastern Europe. So it's just foolishness to say you can't exchange medical literature [internationally]. So anyway, we started going forward with them. Actually, the fall of the Soviet Union kind of got in the way of that project, but they ultimately came back, the same guys, and said, "Well, you know, we agreed to this. If the Soviet Union would agree to this, now we're Russia, of course, do it. But in the meantime, the Chinese actually moved somewhat faster—the Red Chinese. They wanted a center in Beijing.

DS This is a National Library of Medicine center?

DL Yeah, MEDLARS Center.

DS So you provide access to our literature in China?

DL Yeah. More than that, actually. There was a set of centers, the MEDLARS Centers, so-called, created largely by Marty Cummings and Mary Corning, who was kind of his person for international affairs. They were like a two-person State Department. But when the thing started, when the computer got working, basically, a study was commissioned in 1960 to test the feasibility. Could a computer do this for a hundred journals? And so forth. General Electric was the contractor. They came back and said yes. By '64, they actually had a working system.

Marty Cummings certainly knew very well, you look for the quarter under the street lamp, so to speak. But the rest of the literature is in England—Sweden and England. So the first two centers were in Karolinska, and in the British Library. Then, after that, you got your hands on it, what you really have to have. Then they dealt with France and Germany. So by the time I got here, they had those all well in hand. But the arrangement was that we wanted—we, NLM, wanted a place in these different countries to accept the responsibility to do whatever was necessary in the country, so that the right people could get access to the MEDLINE file, whatever that took. And we wanted [a field in MEDLINE for] the country, of course, to identify the Karolinska and the



George Franklin and Kent Smith, ca. 1980s.

National Library of Medicine collection.



Paper cut silhouettes of Mary and Don Lindberg, handmade by a street artist they met while visiting China, ca. 1990s.

Personal collection of Donald A.B. and Mary M. Lindberg.

British Library, because the [journals] are different in each country. We didn't undertake to do that, but we wanted one place to work with, because of just the limited personnel and all that. Plus, in those days, of course, everything was harder. So that was a very good arrangement. Then, there's indexing of the literature. We were happy that the British would undertake to index their literature, because they do it quite well, and the French index in France and so forth.⁸¹

At the same time, the institution was under the obligation to the Congress and OMB and so forth, but largely to the Appropriations Committee, to, I guess you would say, utilize appropriated funds for the bare necessities of running a library. But providing MEDLINE service was not considered a bare necessity of running a library. I guess they got them convinced that making the files was essential. Then there would be a marginal cost to provide access to the files. We'll charge and recover the marginal cost of providing access. There was a pricing committee that, thank God, Kent Smith used to chair. But I mean, they burned up hundreds and hundreds and thousands of hours, getting all this accounting done just right. You know, again, the publishing people hated that—Elsevier and their system and competition and all that crap.

Anyway, we hewed very, very carefully to these congressional agreements. Consequently, that meant we had to ask, how would you do this charging business with the foreigners? I don't remember exactly the circumstances before I came, but I remember that it was worked out that I could

agree to it, that we would somehow or another figure out the cost of everything, whatever services we were providing to them, minus whatever services they were giving to us. Then, there was the bare cost, but they

didn't pay taxes, so they didn't contribute to those appropriated funds; they were doing the basic stuff. So we added 15% or something like that. I mean, there's a lot of folderol, basically.

In the end, the true actual marginal cost to make a MEDLINE search was \$1.25 or something like that—way below the cost of parking a car at the doctor's office. But it was an obstacle, and not everybody has really even got the \$1.25. Plus, of course, we were trying to get the doctors doing searches, and they're not getting reimbursed the way the lawyers are. The lawyers call it research; they just mark up the cost, they don't care what the hell you're charging. Multiply it by three and bill the client. Doctors can't. You know, they're somewhat cheapskates anyway. So, that was somewhat of an obstacle, even though it was a small cost, and that was honestly done.

The quid pro quo would have to do with things like, well, if you're doing the indexing, we will subtract that from what you otherwise would owe us for services. To some extent, this is still going on. I mean, I won't go into the details of it, but I guess we're about to shut off service to one of the foreign countries because they just don't pay their bills.

But the other thing was, we decided that—I think I was party to that—it's all going to be dollars, because we do not want pesetas and all those other things we don't know what the hell to do



Personal collection of Donald A.B. and Mary M. Lindberg and National Library of Medicine collection.

Dr. Lindberg in costume at the opening of NLM's Frankenstein exhibit, October 30, 1997. "This exhibit explores some of the fundamental questions of all time," Dr. Lindberg explained. "Why has the public at times feared science? Have changes in communication technology made the public feel close to the center of decision-making regarding science policy? If so, has this allayed their fear of science?" Elizabeth Fee, Ph.D., then-Chief of NLM's History of Medicine Division, said, "We also see this exhibition as an opportunity to recognize some of the social, ethical, and philosophical concerns raised by such scientific endeavors as cloning, xenografting, the Human Genome Project, and other new developments in biomedicine." Explore this exhibition at: <http://www.nlm.nih.gov/frankenstein/>

with, and we'll be arbitrageurs or something before we're done. So we said, "You guys gotta buy dollars." But the intent was to reduce it down "even Steven," to get enough in so-called quid pro quo services that it would come out to be flat, or close to it. And then they fall behind.

JA I was supposed to ask you the last time some grand philosophical question. And I'll warn you ahead of time what I'm going to ask—about what you think your greatest accomplishment was prior to coming to NLM. And then I'll ask you about your greatest accomplishment since you've been at NLM. But in light of the history of medical informatics, let's say, what do you think your greatest accomplishment was prior to coming here?

DL Well, I think what I would be most proud of is that I figured out why everybody was dying at Columbia

Presbyterian in the open-heart surgery, because they were using silicon sprays.⁴²

JA That was very early in your career.

DL Yeah, it was early in open-heart work. Actually, it was at a period when the literature was a year or more behind progress in the field—maybe even two years. Everything was happening by meetings and by telephone calls. The literature in those days was very, very behind—well, it was as far behind as the early AIDS stuff. When the AIDS things came up, we started keying in the abstracts for our meetings. But the delay is very great, yeah. So I was proud about that.

JA As you should be. Now, what about since you came here to NLM.



Personal collection of Donald A.B. and Mary M. Lindberg and National Library of Medicine collection.

Donald Lindberg with grandson, Martin, in his NLM office, ca. 1999.

DL Well, I think the best decision I made over all those years was to get a long-range plan going in '84-'85.

JA Can you tell us more about that? That was on our list.

DL Yeah. To me, it was a natural thing to do, although I'd never done it before anywhere. I encountered this wonderful institution that I could easily admire, and I did admire. I'd look around for "Where's the plan? Where's this, that, or the other thing?" And there was no plan. For 148 years, they'd made good decisions, but certainly there was no plan that guided them. I don't think anyone opposed it. They thought it was kind of a curious thing to do.

JA What made you think of it? What motivated you to put your energy that way?

DL It was pretty clear that while there were excellent people here, all doing a very good job, people didn't know the other people's jobs or points of view. It was much more sharply partitioned than now. So, for example, when you go through that little tunnel to get to Lister Hill, I used to think, "Man, they may as well have these three-foot-high Roman letters that

I could see that the people in the library needed to have a process whereby they would pool their wisdom and insights.

say, "Don't walk through this door unless you're a Ph.D. researcher. Otherwise, stay out." There were really major divisions between research and library operations, whatever it is. I remember when I was looking at the place and meeting some of the folks, that Lois Ann Colaianni, who's head of Library

Operations, said to me, "Well, if you come, I hope that it could be arranged that Library Operations could do something in the way of the research." I said, "Lady, count on it! Count on it." So I actually had to deliberately set about on a course to break down the barriers between the Lister Hill research people and the Library Operations people—I mean, they were totally artificial barriers, but they'd become traditionalized. There were no

joint projects between the two.

JA Did the long-range plan play into this goal?

DL Well, I made it so that it would, yeah. But I mean, I was just trying to get back to your question of, why do this to begin with? Why would you want to plan to begin with, and what would come out of it? Just thinking that I haven't thought about it quite that way before, but it was obvious to me that the people here, while excellent, weren't working together the way you would like to see. I mean, they actually had



In Aspen, Colorado with Ted Shortliffe.

Personal collection of Donald A.B. and Mary M. Lindberg.



Personal collection of Donald A.B. and Mary M. Lindberg and National Library of Medicine collection.

Mary and Don Lindberg in costume as "Lord and Lady Lindberg" for a party on May 19, 2007 to celebrate the return of a long-missing medieval manuscript -- the Latin Treatises on Medicine, written in England in the 12th century on vellum (calf skin) -- to the NLM collection.

long boring discussions about matrix management versus the whole management baloney. You know, hierarchical versus matrix. God! What nonsense!

DS So did things like the UMLS [Unified Medical Language System®] and the IAIMS [Integrated Advanced Information Management Systems] come out of that long-range plan?

DL I started UMLS because I knew we needed to do it.

DS How did you know you needed to do that?

DL Well, it started with a whole bunch of e-mails between me and Schoolman and Betsy.

JA Can you tell us about that?

DL Well, but let's finish the rest of it. So, what were the expectations to have a plan? Well, firstly, I wished that I had a plan, because then I'd know whether I was on schedule or not. But secondly, I could see that the people in the library needed to have a process whereby they would pool their wisdom and insights and so forth. And then, if that be the case, look at all the other wonderful people I'd encountered around the world. Let's get them in, and what would be the rationale? To the library people, it actually began to feel quite natural to talk about hearing from the people we're trying to serve. It's intuitively obvious that a top-down

“Well, who is it I'm trying to serve, who do I have contact with, and who would be good people to help?”

plan is going to be a useless plan, so I never had any intention of doing that.

But we're doing a bottom-up plan, trying to get in contact with the people we're going to serve. Then, as you started enumerating those things, that put us ahead. Everyone thought through: “Well, who is it I'm trying to serve, who do I have contact with, and

who would be good people to help?” and so forth. It was salubrious, a good thing to do—definitely the best decision I've ever made. And everybody got kind of enthusiastic about it. That's the other part of it—planning can make people very anxious. I mean, supposing that there's a community of so-and-so, and it is said in the newspaper, “The

planning commission is going to make a plan for your town.” You think, “Oh, my God, I hope not.”

DS You don't want them to change anything.

DL Right. And you don't want them planning for us.

DS So you had one plan in '84, and you're still working on that plan?

DL It's a 20-year plan. It went through 2005, starting a new one.

DS Twenty-year plan?



Personal collection of Donald A.B. and Mary M. Lindberg.

Fishing in Alaska with Rob Logan, NLM Communications Research Scientist and a friend from Missouri days; ca. 2000.



Personal collection of Donald A.B. and Mary M. Lindberg.

Dr Donald Lindberg vacationing in Maine with Dr. Thomas Detre, who served on the NLM Board of Regents (BOR); ca. 2000s.

DL Yeah.

DS *Did that have the molecular biology stuff in it?*

DL Oh, well, that's one of the very best things that ever happened. Alan Maxam,⁸² yeah. So that's exactly how NCBI [National Center for Biotechnology Information⁷³] came out of it. That was a fabricated name, of course, but the idea that there was this field and nucleotide and sequences and all this kind of stuff, and no one was keeping track of it. That's a library problem. That was very, very helpful. I guess you could say that's unintended consequences, but you could also say that discovery waits for the prepared mind, because we were definitely ready, that was what we were doing. We were ready, and we were listening to the folks. And it wasn't all that obvious, because I think I've told you that Lederberg was on that planning thing. Rich Roberts was sitting right there, pre-Nobel, but just as bright as ever. Neither of them saw it. I mean, maybe they understood it, but they didn't tell us. So it was kind of a magic moment. I remember it very, very well. So that was a highlight, definitely a highlight for me, because by then, we knew what to do about it. This is the kind of stuff that Kent picked up on very, very fast. We immediately called Fran Howard.⁸³ I don't know if you know Fran Howard. She's deceased now.

JA *When did she pass away?*

DL Oh, a year or so ago. She just got old. It wasn't an unhappy thing, because she stayed on the job here until she was way, way, way old. I encouraged her to keep going. But anyway, she actually was a political

appointment. Interesting thing. It's one of the few nice things that Richard Nixon ever did in his life, as far as I know. She had campaigned against him, for her brother [Hubert Humphrey]. So he was decent. She had, of course, resigned from her job—she was in

the State Department, I think, before that. Originally, she worked for Eleanor Roosevelt. She goes back a long way. But I think she was working in the State Department when her brother ran for President. So of course, she resigned her job and went out campaigning.

When it was all over, Nixon sent her here. I guess they talked with her about different places you could be, and sent her here. It was a smart thing to do. I mean, it was good for her, and she immediately tried to be useful and helpful to everybody around. She was in extramural programs, because the activities she'd been in were Food for the World, famine stuff, and all like that, tramping around the world. She was very good. But anyway, infinitely well-connected. She was a real politician's sister. I mean, not only was she good at names—she'd know your name right away—but she'd also know your grandfather's name and your father's name, and which campaign you met in, and which cities. She was unbelievable. So we talked with her, and we immediately took the opportunity, as it were, to talk to Claude Pepper. I didn't tell you this?



National Library of Medicine collection.

The National Library of Medicine (NLM) has contributed to an increasing use of electronic images for clinical medicine and biomedical research. Dr. Lindberg stands in front of one of the largest books in the Library's collection, a Plexiglas representation of the Visible Human Male. The Visible Human Project was established in 1989 and since 1995, offers digital datasets of MRI, CT, and photographic cryosection images of adult male and female anatomy. To date, these free resources have been used by more than 3,500 licensees worldwide.

DS *You did tell us about Claude Pepper when we spoke in June.*

DL Because, I mean, to me that was a learning experience, too. We sort of reasonably quickly figured out what it is we wanted the thing [that became NCBI]

to do, what we wanted to say—at least in sort of scientific computer talk terms. Dan Masys was here then. It was not something that Mr. Pepper could understand. He was Law Review, Harvard Law School grad, and all that kind of stuff, although he gave you a whole lot of country lawyer act. It’s just double-talk, most of what computer people do. And if you add that into molecular biology, it’s totally opaque. So we actually hired a writer, and Fran came up with a writer.

DS So in the other interview, you mentioned about Claude Pepper helping with the IAIMS program. He also helped with NCBI.

DL No, I don’t associate him with IAIMS. He may have helped with IAIMS too, but I would associate it more with Mark Hatfield and Fritz Hollings.

DS For the IAIMS?

DL Yeah. Hollings actually—and remember, he was a presidential candidate, too. He was really quite a senior guy. He stayed in the House and Senate conference committee until 2 a.m. to get us something like \$4 million for IAIMS, without which it never would have gotten started.

JA If you have time, I’d sure like more of the story of how NCBI was created.⁷³

DL Sure. Well, of course, one of the issues is how to get it organized. What Mr. Pepper gave us was authorizing legislation, carefully crafted authorizing legislation, that we were 100% in agreement on. But

actually, truth to tell, at least in those days, I had been authorized to do everything under the sun, far more than we had any money to do anything with. So it wasn’t exactly that we felt legally unauthorized to do NCBI, but certainly it’s very much nicer to have it explicit than to have, let’s say, some dispute about, well, why isn’t heart-lung [National Heart, Lung, and Blood Institute] doing it, or somebody else like that? No one was doing anything. But it’s nice to have it explicit. But also, then of course the House

Appropriations Committee—in those days, Congressman Bill [William Huston] Natcher was the Chairman of that Committee—and Natcher was very, very strict about

the idea that he liked the Appropriations Committee appropriating money for stuff that had been authorized by whatever committees were supposed to do it. That was the process he was very keen on. This gave NLM an authorization.

It happened I was down in the Congress one day, with no idea this was going to happen, and Mr. Pepper walked into the House Appropriations Committee. It was, at least in those days, a very gentlemanly operation. So they always give the courtesy of the floor to a member. He said he was there to tell them about how they ought to appropriate some money for this NCBI thing for NLM. And so Mr. Natcher said, “Well, we understand that you’re putting in authorization legislation.” Mr. Pepper said, “They don’t need any. They don’t need my authorizing legislation. They’ve got plenty of authority. What they need is \$8 million.

Discovery waits for the prepared mind.



Bob Mehnert and Kathy Cravedi with the rest of their NLM Office of Communications team, in December 2001.



Dr. Lindberg with Dr. Marion J. Ball, and Director of NLM’s Specialized Information Services (SIS) Dr. Steven Phillips at the Cosmos Club in Washington, DC, 2001.

Give that to them.” I was absolutely astounded. It happened just about that smoothly.

DS Wow.

DL So he was a tremendously big help for getting NCBI going. There’s no doubt at all about that. I mean, it really ought to get named for him. Unfortunately, he fell ill, and I think NIH rushed around and named another building after him [building 31]. I guess it’s good if it made him feel good before he died. I think it was a bowel cancer. He was old, of course. He had learned to live with all these damned infirmities. I mean, he had ear things and he had Coca-Cola-type glasses, from having cataracts removed, and a pacemaker. But he could still talk the socks off anybody. I mean, he could talk the birds down out of the trees. He was a wonderful speaker. I’ve really seen him outshine half a dozen distinguished speakers.

He could talk the birds down out of the trees.

JA So you got the money and ran with it?

DL You bet! Well, of course, then the next step is, we needed to come up with space, of course. No one gives you a goddam thing at NIH, but we figured we’d do the space part. FTEs [full-time equivalent staff positions] were the thing that was tough then. So I went to Ed Rall, who was essentially Deputy Director for Intramural Research, and he was a fairly tough old character. I thought he was nice, but he certainly was a tough character. So anyway, out of whatever process it was of begging and pleading and all that,

we ended up with 12 FTEs. I remember he phoned me, I came over, and he said, “Okay, I’m giving you 12 FTEs to start this NCBI thing. Now, let me tell you, I don’t want you to use one damned FTE on any damned administrator.” “I guarantee it.” [laughter] I mean, he was just for the science. He was kind of a protector of David Lipman, so that worked out pretty well, too. Dan Masys was actually the first Director of the center. I would consider him that. Dennis Benson was there, too. But Dan did a very good job in that, as everything else. But he fairly quickly reached the point

where he said, “You know, I can do this, but you really gotta get somebody whose heart and soul, 150% of his activity, is in this field. We’d already talked about Lipman, and we agreed if we can persuade David to do

it, that that would be an ideal thing, so it happened that that could be done. But it started with 12 slots, and the rest of NLM providing all of the administrative purchasing, personnel, all that crap.

So what else about NCBI? Well, I mean, there’s all kind of scuttlebutt you could get, I guess, from David [Lipman]. One of the big, I guess, sort of high-level decisions had to do with a database at LANL, Los Alamos [National Laboratory], that a guy named Goad had started for nucleotides. Goad was a very good person, and he did a good thing in starting GenBank, which is going along very well. NIH was paying for it. So we had a meeting. I think it was coming from NIGMS [National Institute of General Medical Sciences] and maybe NSF [National Science Foundation]. I forgot, maybe NLM was in it—perhaps



National Library of Medicine collection



National Library of Medicine collection

Don listens to carolers singing and greets guests with Mary at the annual NLM holiday reception they generously sponsored.

so. But I remember meeting with Ruth Kirschstein, who was in charge of NIGMS then. It was just clear that NIH was shipping \$2½ million a year to Los Alamos and getting nothing out of it. The service was awful, and submissions were backed up. Walter Goad, I think was the guy's name, was, as I say, a very fine guy and a good scientist, but not for doing that kind of a computer job. So we made the decision, no more money for that—we're going to do it at NLM. That was a fairly major change.

Partly to guard against anyone feeling too super-massively bent out of shape, we decided that those monies which are saved, we won't just sort of put in Lipman's account [for NCBI's budget], but we'll take those monies and put them into Milt Corn's EMP [extramural program] account, you know, for giving out for extramural grants, feeling that that was sort of somewhat more fair, since it was money going out there someplace into university land or some other

kind of land. So that was the way it was done. Then Corn and company were able to support microbiology kind of awards, and they did it. So we felt that was fair. And of course, Lipman immediately just outshone everybody else. I can remember [before NLM started running GenBank] I kept hearing, "The Europeans are impossible to work with; the Japanese are impossible to work with." And all these exchanges of data were months and months behind, and don't work, and there's nothing but griping.

David [Lipman] picked up Jim Ostell as his chief tech guy, who's been very good. He came up with an abstract syntax notation number one, ASN.1,⁸⁴ and we just all decided, "Okay, ASN.1, that's the way we're going to exchange it. Period, end of report." As an international standard, I think the Europeans might even have adopted it. Once we started that, and those guys started doing things in a timely fashion and listening to people, instead of just writing snotty



National Library of Medicine collection.

Dr. Alexa T. McCray, then-Director of the NLM Lister Hill National Center for Biomedical Communications, and Dr. Lindberg view a software demonstration in the NLM Reading Room, ca. 2002.

e-mails, certainly within a year, way less than a year, it was up to a daily exchange with Europe and Japan, both ways.

So, part of it was decent management, and part of it was being determined that it was going to work. And part of it was a little technical solution. Where would we be without XML and stuff like that? This was just a nice, reasonably simple-minded scheme, but it is a scheme. And that's how all the records got exchanged. So that was a good surprise, very good surprise.

JA One thing I didn't get to ask about last time, and I think it's something NLM's done that has made a huge impact, is MEDLINE®.

DL Yeah.

JA I wonder if you can tell us how that came about.

DL Oh, yeah, that was very straightforward. Everybody here was pretty determined that we get out from under this marginal-cost, fee-for-service stuff. Kent [A. Smith] particularly was double sick of it, because of these thousands of hours spent honestly doing it all. But then two things happened. Where was the money going? Well, first of all, a tremendous amount of it was going for NLM, paying for telephone service, because—. Here is a little story I'd love to, if I ever get any spare time, investigate in our history. But there was a certain point where they made a commitment to these services. You could make an ELHILL search,⁸⁵ and then you could get your thing back and so forth. And somewhere along the line, implicitly or explicitly, they made a decision that

everybody in the country ought to be equally able to do that, which now you wouldn't think much of, but that was pretty remarkable, given the day, because I can remember very, very well as a kid somebody saying, "Call California?! You ought to write a couple of letters first and get it all ready." And calling California cost a hell of a lot more than it cost to go from Brooklyn to Manhattan. So everything was very distance priced, and yet they made a decision that they were going to charge the same thing, ocean to ocean. So I think that was a very, very profound and important and right decision. I can't quite pin down the details. As I say, if I get some time, I'd like to work on it.

So a lot of what we were paying for with these marginal-cost things were the phone-line charges. Of course, you know, in those days there weren't even 800 numbers. I mean, even that was a big goddam deal when 800s came in. So we were just leasing lines to different cities. For instance, I remember talking with Fritz Hollings about South Carolina and asking him how were things going, were we getting good service, and so forth. I won't imitate his accent, but basically he would say, "I really can't tell, but I guess it's fine in Charleston." So we started looking: let's make a map of which counties in Carolina actually have halfway reasonable phone service, that we're actually subsidizing. And the rest of them are paying through the nose for any kind of call. If you wanted to do a search, if you wanted to do a plot—which I did—of which counties have doctors that are really users, well, it was very revealing. But anyway, it was not hit or miss, but it was a difficult business to manage, leasing



Personal collection of Donald A.B. and Mary M. Lindberg.

Donald and Mary Lindberg celebrating their 70th birthdays with cakes and friends at a party Marion Ball organized at the Cosmos Club, in Washington, DC, in 2003.



Personal collection of Donald A.B. and Mary M. Lindberg.

Don King and Mary Lindberg sharing a laugh at the Lindbergs' 70th birthday party; 2003.

those lines. It was a little area and activity and so forth. So a lot of the money went there. Then, some of the money went to billing, because we were required to do the billing.

And then by the time we got to Grateful Med, that was a system where we had to give you a diskette with the software. That meant that we were maintaining it for Macs, for PCs, for God only knows what else, in all these different versions. That was an overhead of at least a million or so dollars a year. And all of a sudden, this stuff started to fall apart. I mean, like, for instance, Internet came in, and we right away started using Internet. Well, that removed \$14 million a year. I mean, I didn't care what they charged me to join Internet. That displaced a lot of cost. And then, of course, ultimately, as we all remember, the World Wide Web—well, Mosaic came along. But Mosaic was just a potpourri of any kind of Web browser

software that would do anything. But Wais was the one mostly used, W-A-I-S. Gopher was on it—Minnesota won. Mosaic was all that stuff together. Here's a disk.

I could see the World Wide Web was the most interesting and sophisticated of the four, but I certainly didn't see that it would sweep the world the way it did. I mean, I don't know what I would have done if I had seen that. Buy Champaign-Urbana or something! [laughter] So it did, in any case. It came to prevail. The effect of that was I don't need to care about all these versions. I don't need to care about Macs and PCs and all the other stuff. I don't care—I'll let these guys maintain it. Call it Netscape or Mosaic or whatever you want to call it.

DS And you also got rid of all your phone charges.

DL Right! So that meant that we could actually see the end of the necessity to recoup this money.



Personal collection of Donald A.B. and Mary M. Lindberg.

The Lindberg family, ca. 2004.

DS *So that allowed you to give everything away.*

DL Yeah, very close. It got down to where there was a million dollars that we were paying to another federal agency to handle the billing, which I wanted to get rid of. [laughter] We took the thing to Tom Harkin and Arlen Specter. Let's see, we did it in two stages, actually. The Internet folks were none too happy about letting us in, but we did that with the Senator from Tennessee, Bill Frist, who is a doctor [a heart and lung transplant surgeon]. He had a hearing about something or another, and I was asked to participate, and I did participate. I began to say something, trying to explain about MEDLINE® and MEDLINE searching, and he just said, "Wait a minute. The day never happened that I didn't do MEDLINE searching at Vanderbilt. That's a wonderful thing!" And he expressed himself very, very positively about it.⁸⁶

I had earlier hired a gal named Kathy Cravedi—I don't know if you've ever encountered her. We have a wonderful guy, Office of Public Information, Bob Mehnert—marvelous, skillful writer, and very good, loyal guy in every respect. But he isn't a PR man. In fact, that's been bred out of anybody in government, whereas Kathy was actually the Chief of Staff for Claude Pepper. That's when I met her.

So Pepper, of course, ultimately died, and she did a few other things. I think she might have worked for Congressman [Edward R.] Roybal for a while. Anyway, I went

out and got her. And happily, Mehnert—she works for Mehnert—he could very happily embrace her as the missing link. She'd gotten on the job finally, and I asked her to come down with me to this hearing.

I said, "You've had all this experience with Senator Pepper, running these damned hearings. You'd better come down and see what it feels like on the other side of that big bar." And so she did. When we were going back to NLM, I've forgotten what it was we were talking about, but some next meeting, or something like that, and she said, "Well, aren't you going to ask Senator Frist to do the first MEDLINE search [on Internet Grateful Med]?" I said, "That's a great idea!" It dawned on me I'd done the right thing by hiring someone who's a PR lady. In a thousand years it would never occur to me to do that.

DS *Never.*

DL No. I mean, it was a totally different relationship. So totally obvious to her. So, we created a circumstance where he did the first MEDLINE search on Internet. We filmed all this stuff, of course. I still

have the films; they're quite good. And of course, you know very well what he does. He does a search on stuff he's written, of course. [laughs]

DS *Doesn't everyone?!*

DL Sure. That's what anybody does. And he's sort of cute. "Look! That's a wonderful article. Isn't that an interesting article? Let's see who wrote that." [laughs] So anyway, they're on record as "we want you on Internet." And then we ran that



National Library of Medicine collection.

Dr. Lindberg presents an award to Kathy Cravedi, ca. 2005.



Personal collection of Donald A.B. and Mary M. Lindberg.

Martha (Marti) R. Szczur (center) receives an award from NIH director Elias A. Zerhouni and NLM director Donald A.B. Lindberg, ca. 2004.

for a year or so, and then figured out a way to make it come out so that it could cost practically nothing. There's no point in paying an agency a million dollars to bill for a million dollars. That's nonsense. I think it was a period where it wasn't clear which party was going to be in the majority, but Tom Harkin and Arlen Specter, who are wonderful working together, alternate who is chair of the Senate Appropriations Committee, and they assured that, you know, the policy will change a little bit—naturally, the loyalty of their party—but NIH won't get deserted, and science won't get deserted. Nothing bad will happen. Good stuff will happen, regardless of who's chair. They're a wonderful example—the tops in government, as far as I'm concerned.

No one in Washington believes anything unless they see it on TV, so you've got to have TV. We had a hearing down in Senator Specter's office, and everybody else in attendance. In this case, we asked Mr. Gore to do the first free MEDLINE search. We, of course, taped all this stuff, too. I think I asked Harold Varmus to come down as well. I figured I'm as bulletproof as can be—they may attack me, but they're going to have to take out Varmus and Gore and Specter and Harkin. I think I'm pretty bulletproof.

He did the first MEDLINE search on Internet.

“Well, looks like searching MEDLINE is going to be on the house!”

[laughs] We were turning away from an agreement that we had made with the House Appropriations Committee, and OMB, and all this kind of stuff. But they had a wonderful time. Tom Harkin said, “Well,

looks like searching MEDLINE is going to be on the house!”²⁸ [laughter]

DS Pretty good. So did that PR woman [Kathy Cravedi] help you with the names of some of these projects? I always liked Grateful Med and Loansome Doc.

DL Yeah, me too. I think she might have been a help on Loansome Doc. Grateful Med was a result of a committee—most good things at NLM are committee.

So we're going to have this new service, and it needed a name. They asked me, what are you going to call it? Got a committee together, and they brought back 10 names, 9 of which were terrible, very stodgy, and Grateful Med. I said, “That's it! That's the way to go.” Not everyone liked it.

The most positive I've ever seen any audience respond to Grateful Med was when Mary and I are in Europe someplace, and the young people in that European audience just were (whew!) they were really turned on. They loved that, absolutely adored that. [chuckles]



Personal collection of Donald A.B. and Mary M. Lindberg.

Donald and Mary Lindberg visited Mt. Vernon and posed with the statues of George Washington and his family, along with Cathy Norton, while she was visiting NLM with a group from Woods Hole Marine Biological Laboratory; ca. 2004.



Personal collection of Donald A.B. and Mary M. Lindberg.

Don Lindberg on a fishing trip with his son Jon, brother-in-law, son Don, and Jon's wife Kelly.

Celebrating the 2003 opening of NLM exhibition “Changing the Face of Medicine,” which spotlights America’s women physicians. Explore the exhibition online at: <http://www.nlm.nih.gov/changingthefaceofmedicine/>



National Library of Medicine collection



National Library of Medicine collection



National Library of Medicine collection



National Library of Medicine collection



National Library of Medicine collection



National Library of Medicine collection



National Library of Medicine collection



National Library of Medicine collection



National Library of Medicine collection

DS So do you have time to tell us—I heard you tell a story about meeting Larry Kingsland. I was reading in the transcript about Larry Kingsland, Sr., and I was wondering about the relationship between him and the Larry Kingsland I know at the NLM.

DL Yeah. Well, his dad was a physician, pediatrician. At the time I met him, he was a commissioned officer in the navy and, actually, about to get out. He came to work for me as Assistant Director of—what was I running then? Whatever I was running in Missouri. Yes, I guess it would have been Regional Medical Programs. The head of that was Vernon Wilson, but I was doing something, a portion of it. So Larry Kingsland, Sr., came to work for me. He was a very, very fascinating guy. He had quite a bit of world travel experience. He had a lecture he gave called “Dietary Atrocities I Have Known.” [laughter]

DS Oh, no!

DL But he was interested in information. He was interested in learning. Had a big family of kids, got Fulbrights and traveled the world, and got advanced degrees. A particular project that he worked on was called the Fact Bank.⁸⁷ And in a way it was—you know, the kind of stuff that we’ve all been doing. How do you represent all these different kinds of knowledge, and what kind of terminology would you

How do you represent all these different kinds of knowledge, and what kind of terminology would you make?

make? You know, here’s the brown butcher paper where you start out with the different categories of everything, and branching, and so on like that. He ultimately retired.

But at the time, his son, Larry, who is a graduate of Brown in international relations, because he had been trailing around the world with his father and sisters

and parrot cages and trunks and all the paraphernalia of a family. I’ve forgotten what he did in the interim—not too much of anything. I mean, he treated himself to a year or two as a street musician in San Francisco. He could play autoharp and had a decent voice. I guess he concluded that that probably wasn’t really what a Brown graduate ought to be doing in the long run, and so he appeared in Columbia,

Missouri, and of course I liked him very much and put him on as an electronics tech, which, of course, he’s very precise and good at—whatever he does. I mean, international relations isn’t going anyplace. He wasn’t enjoying San Francisco enough that he was going to become—he was no drug addict, he was just playing. So he thought, “Well, I’ll give it a try.”

A guy named John Long, who was a real electronics tech, had to teach him how to solder. Larry’s studies at Brown didn’t have anything to do with electronics, but Larry was a good, smart guy. We had a very, very nice group of people. They all worked



Personal collection of Donald A.B. and Mary M. Lindberg.

“Captain” Lindberg, navigating his boat.



Personal collection of Donald A.B. and Mary M. Lindberg.

Mary and Don Lindberg celebrate after he receives the American Medical Women’s Association (AMWA) Award in 2004.

for a guy named Guy Morrison, who is an absolute circuit genius, really a brilliant guy, that I hired out of an unemployment office, actually. He applied for a job as a programmer, because he just wanted a job. I remember interviewing him, and he was obviously really a bright guy. I said, “You know, Morrison, I think you probably could do this programming, but you’re no kind of programmer. What the hell are you, really?” He said, “I’m a hardware man.” “Great! All right, let’s do that.” He could just pick up parts and make circuits that would do whatever you wanted them to do. And when they didn’t work—I remember one time I saw him, he just wired-in a regular household circuit and put a light bulb in it, to be some kind of buffer or something. He was really incredible. It was pre integrated circuits, so you’re talking about capacitors and all that componentry.

The university had a policy then that I learned a good bit from, and admired and liked and implemented here at NLM, actually: if a person worked for the university in whatever capacity, they had the right to take a course without charge. They had to qualify and get into the course, but they could take a University of Missouri course without charge. And if their supervisor said it was job related, then they could take a second one—so two at once. I thought it was a pretty damned good idea, because that’s what a university has to give out, is knowledge.

The worth of the institution is the people.

I was totally appalled when I came here to find that the federal government had nothing like that—in fact, quite the reverse. The idea that you would even give a person time off to go get an education! I mean, this required all kinds of haggling. So, once we finally got to the Diversity Council thing—we were the first ones at NIH to put that in—I put in a scheme for paying for employees to go to university courses.

That’s a radical thing; no one does it. Even NCI [National Cancer Institute], with all the money in the world, they don’t do it. They don’t understand the difference between, like, a WordPerfect course and a university course—training versus education. Well, WordPerfect is bad now, but Word or whatever—that just makes people tractable employees—PowerPoint, let’s say, whereas the university course is a credit that goes with you. You can add that up, eventually get a degree, take it somewhere else, maybe take it to another agency. The worth of the institution is the people.

So anyway, Larry started that activity, and ended up with a Ph.D.

DS On the house.

DL On the house, yeah. He was very, very good.

DS Was he here when you came here?

DL Yeah. So we’ve worked together for a long time.

DS Yeah, I guess.



Tenley Albright and her granddaughter with Mary and Don Lindberg.

Personal collection of Donald A.B. and Mary M. Lindberg and National Library of Medicine collection.



Don King, Don Lindberg, and Betsy Humphreys visit in the courtyard during an NLM ice cream social in 2004.

Personal collection of Donald A.B. and Mary M. Lindberg and National Library of Medicine collection.

DL But he always did very good things, and I was on his committee, of course, for the engineering school.

JA Other people you've known: You've mentioned Marty Cummings, the previous NLM Director, a number of times, and I remember him from way back. I wondered if you knew him before you came here, because you had been on the study section.

DL Yeah, study sections and other stuff. I've forgotten what it would be, but other things that NLM had. Yeah, I knew him, I liked him. I still see him. He'll be back here in a week or so.

JA So I wanted to ask if he still....

DL Yeah, he's in pretty good health. Actually, these publishing people were really surprisingly nasty [because of NLM's efforts, spearheaded by Martin M. Cummings, to provide open access to published medical knowledge via Index Medicus and MEDLINE]⁶⁰ I had sort of a conversation about how bad it is getting with the chemistry people and with [NIH Director Elias] Zerhouni, and he didn't seem to understand that it can get a whole lot worse. These people hired lawyers in town, they put private detectives going after Cummings, following him around. People would appear here at the office—like a reporter would show up from The Washington Post and say, "Now, we understand that this guy Cummings is taking his wife all around the world on these junkets at government expense. And we happen to know that they were—" Well, this is idiotic. Cummings, first of all, would never do that, and there's no way you could.

So the Justice Department required that he register as an agent of a foreign power, and report publicly every 30 days: "How much money did they give you, for what purpose?" That reporting cost quite a lot of money and time, and it was all intended to kill NLM. I mean, he couldn't say it any other way. So the whole thing was getting very unpleasant. Marty left with pain going down his left arm, and all that kind of crap. So I knew what I was getting into, but I figured it's not going to happen to me. But they can be very, very, very nasty. They were.

Now, why did I tell you that nonsense? You were asking about something.

JA I asked about Marty. I was just curious.

DL He actually came from the University of Oklahoma. He is an expert in infectious disease, basically. Very nice man. As I say, he's coming back here for something. But he was a great fisherman, so he had a place in town, but also down on Chesapeake Bay. Then his wife, Arlene, had a various string of illnesses, too numerous to even mention. But he kept her in pretty good health—kept her alive, really—and ultimately made a decision that they were going to need more help than he could be. He sold his real estate, and they moved to a retirement home, basically, in Florida.

Mary and I heard about it. I guess we'd probably been in correspondence with them. Anyway, we went down there to see them, feeling, God, it's so terrible. He used to have these places, and now they're stuck in some goddam retirement—. Well, it turns out it's an absolutely wonderful place, 25 stories high, a view



Personal collection of Donald A.B. and Mary M. Lindberg.

Dr. Lindberg with Casimir A. Kulikowski, receiving an honorary degree from the University for Health Sciences, Medical Informatics and Technology, Innsbruck, Austria.



Personal collection of Donald A.B. and Mary M. Lindberg.

Don and Mary Lindberg just after landing on a glacier in Alaska.

from here to eternity. And he's a marina captain or something. [laughs] Everybody wears coats and ties to dinner, and it's a lovely place. Unfortunately she did ultimately die. He's alone.

JA Dean, you had a question about mentorship.

DS Oh, yeah. We interviewed Reed Gardner, and I know that when Homer Warner was trying to retire, or getting ready to retire, Reed was very concerned about what the next generation was, and there was talk at the university that maybe they wouldn't keep the Informatics Department, they'd just fold it into another department. I've sort of seen what happened at San Francisco when Marsden [Scott] Blois died. It sort of just ended that program. I was reading through your transcript, I saw that, you know—.*

DL The UCSF informatics program was getting killed before he died, though.

DS Oh, it was?

DL Yeah, they were very, very not nice to informatics.

DS I was also looking at Missouri, where there's a wonderful transition. When you left, Joyce Mitchell took charge of the medical informatics group. I'm just curious what you thought was key to sort of these transitions in these medical informatics leadership positions, because I'm sort of worried. Some of the people are getting older now.

DL Yeah. It all depends on good people. You've just got to pick the right people. Joyce did a great job. But that didn't all fall in her hands. She just did a really swell job. The critical thing for her was that she had gotten good support from the deans that followed



Courtesy of Kaiser Permanente.

Don Lindberg embraces Morrie Cullen at Morrie's Centennial Birthday Celebration, 2013.

when I was there. But ultimately, they sort of felt themselves dragged into the 20th century, and in need of something called a CIO [chief information officer]. So that was a big decision, should she do that? And I must say I did advise her “yes.” When she asked for advice, I did say, “Yes, but limit the time, and make sure the rascals give you slots [to hire other people] so you can fill in behind yourself and build the department up.” It took a lot of reminders before they actually came through with these slots and all that. They persuaded her to stay a year or two longer. It’s a killing job. It doesn’t run pains down your arm, but it just makes your brain go to sleep.



Mary and Don Lindberg, Michael DeBakey, David Nash, and Steve Phillips, ca. 2007. Dr. Phillips, NLM Associate Director for Specialized Information Services (SIS), studied cardiac surgery under Dr. DeBakey in Iowa.

Personal collection of Donald A.B. and Mary M. Lindberg and National Library of Medicine collection.

DS *And I know you don't like that. You were always afraid that was going to happen to you.*

DL Well, she was afraid that it'd happen to her. She actually took a year, came back here on sabbatical.

DS *Right.*

DL I mean, it worked just right. She got back and got out from under that kind of job and got her brains working very, very well. She made a great contribution to NLM while she was here. You're right, in saying that about Blois. I was trying to think of the guy who was Dean. He was really a jackass. People in molecular biology think they know something, so maybe he did. But he certainly didn't have any appreciation of informatics. He was deliberately killing Blois's program.

DS *That's amazing, because a lot of good people came out of that program.*

DL Absolutely. Well, I mean, to give you an example, Scott [Blois] was due a sabbatical, had filed for sabbatical, was awarded a sabbatical, was in Germany, I think, if I'm not mistaken, and we recompute these training programs every five years, something like

that, so they had competed, UCSF got awarded the thing, sent the notices off. And the Dean says, “No, we don't want it.”

DS *Don't want a training program!*

DL Yeah. While Blois was out of the office in Germany. So I said, “Dean, I'm not going to let you treat students that way. I can't even tell you how the hell many people are on appointment in that program and they are absolutely not going to put up with that shit. That's not the way for Deans to behave. And it's not the way for Directors to behave. I'm not going to put up with it.” So actually, John Starkweather took over the [training] program.

DS *I remember that name.*

DL Lovely guy. I think it took him about four years to work through the commitments that had been undertaken. Well, you know, you hire people, and it gets a little disorganized. I don't know how fast they're going to move through anything, but John was really built-into the old UC [University of California] system. Starkweather was a PhD psychologist, but he'd done lots of work in CAI [computer-assisted instruction]; there's lots of Starkweather systems and so forth. He had been on the university council and all this kind of stuff, so he was not easy to outmaneuver, and he just undertook—and it was his last assignment to salvage those guys and girls—the training program fellows. But the Dean, definitely, deliberately destroyed Blois. You're right. And then Blois's health failed as well. SOB. And the Dean wanted Blois's space, to put more microbiology labs. That was the whole deal. Miserable.

JA *You were also thinking in terms of developing leadership, and developing leadership within transition.*

DL But how do you do a transition if your own university is totally against you—?

DS *That's hard.*

DL And not just unsupportive but against you, that's pretty hard to overcome. I was just protecting students I didn't even know the first names of—just people that were committed to the program. If they're determined to destroy it, they'll destroy it. I can't think of any exceptions.

DS *I suppose you're right about that. I know Bill Stead was worried. I've heard him say things like, "When a Chairman of Surgery dies, they don't consider getting rid of a surgery department. But when an Informatics Chair leaves, they consider*

it. They shouldn't even consider that." How do we make sure that doesn't happen?

DL I agree. How true, indeed. I mean, get services going that are so important they can't do without them. But even that is a danger, because the NIH is going to have a retreat or a leadership something in September, and so they're soliciting topics, as usual. One of the things I'm going to put up, yet once again, is the need to evolve a broader NIH policy about supported database systems, because there, too, you say, "Well, if something is good and used, then they won't want to abort it." But then IS [information science] is sort of like the weather—I mean, it's just taken for granted. It is a problem of success. It's better to have those than problems of failure, but with success, somebody is stuck with paying for it. And



Personal collection of Donald A.B. and Mary M. Lindberg and National Library of Medicine collection.

The Congressional Medal of Honor was awarded to pioneering heart surgeon Dr. Michael E. DeBakey on April 23, 2008, for a lifetime of achievement in medicine, including his cardiac and bypass surgery advances, helping create the military's Mobile Army Surgical Hospitals, and inventing many medical devices and procedures. Dr. DeBakey took the opportunity to urge Congress to do more to provide health care for the poor.

so it isn't research anymore—it's just of service to research people. We started a lot of those programs. After a while, they get big, you've got to bring in some partners. In the molecular biology, we usually can bring in genome people, that's the worst case. But it's all handled on a very ad hoc basis, one program at a time. You can sometimes get everybody together, as we did with LANL [Los Alamos National Laboratory]. There was another problem there, too, with a protein data bank at—no, structures—a structures data bank at the DOE [Department of Energy] lab in Long Island. You know the one I mean?

DS Is that Brookhaven?

DL Brookhaven, yeah. They had innovated, they had undertaken to do this stuff, like the crystallography structures. That's what's in it, is crystallography structures. I've forgotten what the hell they call the thing, but we contributed money to it—NIGMS did—and mostly it was NSF. It just got to be so terrible. Again, everything, all the submissions, backed up, people all over the country griping about “they didn't put my thing in, I can't get it out.” So the funders essentially decided that they really needed to move it to someplace else. I think, actually, in the end, this has ended up in the hands of a gal at Rutgers, if I'm not mistaken. I think things have smoothed out, but that's a very ad hoc kind of an arrangement. Say like one of the things that NLM started—I personally got started—was GeneTests about 12 years ago [which transitioned to the Genetic Testing Registry (GTR®)⁸⁸ in 2013]. It was sort of obvious to say, “Who are you trying to serve?” Well, the people who see genetic problems are basically pediatricians and GPs [general practitioners], and what the hell do they know about the genetics stuff? It's hard enough to keep up on the medical part of it. I mean, I knew perfectly well a problem was going to come, a patient was going to say, “Well, I want a genetic test.” The doctor's going to say, “I don't know whether to send saliva or blood or your left finger, or what the hell to do.” [laughter]

So anyway, that got built by Bonnie Pagon actually, University of Washington. Joyce [Mitchell] started it, and she had a clinical partner at Missouri that got recruited away, and so she recruited Bonnie Pagon, turned it over to her, and she's done well. But now it's very heavily used, so therefore more expensive—good

Information science is sort of like the weather—I mean, it's just taken for granted.

and all that, but it's a problem of success. So we took in Genome [the National Human Genome Research Institute (NHGRI)] as a partner. It's okay. But it's just that if it's good, it's used, but then people take it for granted. And will that be the last database? Of course, it won't. Some of it NCBI can just do automatically, but other stuff will get invented by other people, like this database of all those enzymes that cleave things in various places. Well, Rich Roberts started that. I mean, he invented the technology in his own lab. Actually you can make some kind of little database of it, and actually share it with your friends and colleagues. Before you know it—.

DS You're running a computer lab, a computer department.

DL Well, and then somebody's got to maintain the damned thing. He left. He used to be Watson's deputy. He left that and went to work for New England Biolabs. I've forgotten who inherited the database, but no doubt NIH—some part of NIH is paying for it, I don't doubt that.

DS That is interesting.

DL Yeah. Whereas if you just putz around and the thing fails and no one gives a damn, it's no problem at all. [laughter]

JA An unexpected consequence! [laughter]

DS Right. Failure is good. Solves the funding problem. I think we should let you go—it's getting late. I'm feeling sorry for you. [laughter]

JA It's been a long week.

DL I'm going to have a very nice dinner tonight with Mary and a guy who was an Amherst classmate and his wife—another general surgeon. I'll be in good shape.

DS Good. Well, we ought to let you go.

DL Yeah. Thanks.

[Published March 26, 2015; updated September 4, 2015]



Conversations with Medical Informatics Pioneers

For additional Conversations with Medical Informatics Pioneers, please visit:

<http://lhncbc.nlm.nih.gov/project/medical-informatics-pioneers>

References

- * Ash JS, Sittig DF, interviewers. *Conversations with Medical Informatics Pioneers: an oral history project*. Goodwin RM, Ash JS, Sittig, DF, editors. Bethesda: U.S. National Library of Medicine; 2015. Available from: <http://lhncbc.nlm.nih.gov/project/medical-informatics-pioneers>
1. Lindberg DA, Humphreys BL. Medical informatics. *JAMA* 1996;275(23):1821-2. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/8642729>. Accessed March 10, 2015.
 2. Lindberg DA, Humphreys BL. Medical informatics. *JAMA* 1997;277(23):1870-2. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/9185808>. Accessed March 10, 2015.
 3. Winn DM, Wolfe JF, Lindberg DA, Fristoe FH, Kingsland L, Sharp GC. Identification of a clinical subset of systemic lupus erythematosus by antibodies to the SM antigen. *Arthritis Rheum.* 1979;22(12):1334-7. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/391237>. Accessed March 10, 2015.
 4. Lindberg DA, Riecken HW. Future programs at the National Library of Medicine. *Bull. Med. Libr. Assoc.* 1986;74(4):344-52. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=406287&tool=pmcentrez&rendertype=abstract>. Accessed September 10, 2014.
 5. Lindberg DA. National Library of Medicine: the view at 150 years. *J. Am. Soc. Inf. Sci.* 1987;38(1):34-9. doi:10.1002/(SICI)1097-4571(198701)38:1<34::AID-ASI7>3.0.CO;2-R.
 6. Lindberg DA, Schoolman HM. The National Library of Medicine and medical informatics. *West. J. Med.* 1986;145(6):786-90. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1307151&tool=pmcentrez&rendertype=abstract>. Accessed March 6, 2015.
 7. Lindberg DA. The National Library of Medicine and its role. *Bull. Med. Libr. Assoc.* 1993;81(1):71-3. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=225736&tool=pmcentrez&rendertype=abstract>. Accessed March 10, 2015.
 8. Board of Regents of the National Library of Medicine. Resolution to congratulate and commend Donald A. B. Lindberg, M.D., Director of the National Library of Medicine, NIH, for more than 30 years of visionary and transformative leadership. 2015. Available at: http://www.nlm.nih.gov/news/bor_resolution_lindberg_2015.html. Accessed March 10, 2015.
 9. Collins FS. NIH Director's Statement on Dr. Lindberg's retirement - The NIH Director - National Institutes of Health (NIH). *NIH Dir.* 2014. Available at: http://www.nih.gov/about/director/11062014_statement_lindberg.htm. Accessed March 11, 2015.
 10. Lindberg DA. HPCC and the National Information Infrastructure: an overview. *Bull. Med. Libr. Assoc.* 1995;83(1):29-31. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=225993&tool=pmcentrez&rendertype=abstract>. Accessed March 10, 2015.
 11. Lindberg DA. Transferring research through high performance computing. *Stud. Health Technol. Inform.* 2000;76:3-10. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/10947499>. Accessed March 10, 2015.
 12. Lindberg DA, Humphreys BL. The High-Performance Computing and Communications program, the national information infrastructure and health care. *J. Am. Med. Inform. Assoc.* 2005;2(3):156-9. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=116249&tool=pmcentrez&rendertype=abstract>. Accessed March 10, 2015.
 13. Lindberg DA, Humphreys BL. High-performance computing and communications and the national information infrastructure: new opportunities and challenges. *J. Am. Med. Inform. Assoc.* 2005;2(3):197. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=116254&tool=pmcentrez&rendertype=abstract>. Accessed March 10, 2015.
 14. Lindberg DA, Siegel ER. G7: a framework for international cooperation in medical informatics. *Proc. AMIA Symp.* 1998:15-8. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2232060&tool=pmcentrez&rendertype=abstract>. Accessed March 10, 2015.
 15. Lindberg DA. Diffusion of medical information systems technology in the United States. *J. Med. Syst.* 1982;6(3):219-28. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/6750022>. Accessed March 10, 2015.
 16. Schoolman HM, Lindberg DA. The information age in concept and practice at the National Library of Medicine. *Ann. Am. Acad. Pol. Soc. Sci.* 1988;(495):117-26. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/10318632>. Accessed March 10, 2015.
 17. Lindberg DA, Siegel ER. On assessing the impact of medical information: does MEDLINE make a difference? *Methods Inf. Med.* 1991;30(4):239-40. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/1762577>. Accessed March 10, 2015.
 18. Lindberg DA, Siegel ER, Rapp BA, Wallingford KT, Wilson SR. Use of MEDLINE by physicians for clinical problem solving. *JAMA* 1993;269(24):3124-9. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/8505815>. Accessed March 10, 2015.

19. Lindberg DA. Information: an interconnected world. *Acad. Med.* 1993;68(8):606-7. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/8394715>. Accessed March 10, 2015.
20. Lindberg DA, Humphreys BL. Computers in medicine. *JAMA* 1995;273(21):1667-8. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/7752407>. Accessed March 10, 2015.
21. Lindberg DA. The modern library: lost and found. *Bull. Med. Libr. Assoc.* 1996;84(1):86-90. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=226129&tool=pmcentrez&rendertype=abstract>. Accessed March 10, 2015.
22. Lindberg DA, Humphreys BL. Medicine and health on the Internet: the good, the bad, and the ugly. *JAMA* 1998;280(15):1303-4. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/9794299>. Accessed March 10, 2015.
23. Lindberg DA. MSJAMA: the National Library of Medicine's Web site for physicians and patients. *JAMA* 2001;285(6):806. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/11176923>. Accessed March 10, 2015.
24. Lindberg DAB. Medicine in the 21st century: global problems, global solutions. *Methods Inf. Med.* 2002;41(3):235-6. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/12162150>. Accessed March 10, 2015.
25. Lindberg DAB. Biomedical informatics: precious scientific resource and public policy dilemma. *Trans. Am. Clin. Climatol. Assoc.* 2003;114:113-20; discussion 121. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2194525&tool=pmcentrez&rendertype=abstract>. Accessed March 10, 2015.
26. Lindberg DAB. Searching the medical literature. *N. Engl. J. Med.* 2006;354(22):2393; author reply 2393. doi:10.1056/NEJMc066137.
27. Siegel ER, Logan RA, Harnsberger RL, Cravedi K, Krause JA, Lyon B, Hajarian K, Uhl J, Ruffin A, Lindberg DAB. Information Rx: Evaluation of a new informatics tool for physicians, patients, and libraries. *Inf. Serv. Use* 2006;26(1):1-10. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1610110&tool=pmcentrez&rendertype=abstract>. Accessed March 10, 2015.
28. Lindberg DAB, Humphreys BL. Rising expectations: access to biomedical information. *Yearb. Med. Inform.* 2008;165-72. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2441483&tool=pmcentrez&rendertype=abstract>. Accessed March 10, 2015.
29. Lindberg DAB. *The Computer and Medical Care*. Springfield, Illinois: Charles C. Thomas; 1968:210.
30. Lindberg DA. Medical computing high and low. *J. Am. Med. Inform. Assoc.* 1995;2(6):337-41. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=116276&tool=pmcentrez&rendertype=abstract>. Accessed March 10, 2015.
31. Lindberg DA. Information systems to support medical practice and scientific discovery. *Methods Inf. Med.* 1989;28(4):202-6. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/2695774>. Accessed March 10, 2015.
32. Lindberg DAB, Humphreys BL. 2015--the future of medical libraries. *N. Engl. J. Med.* 2005;352(11):1067-70. doi:10.1056/NEJMp048190.
33. McCray AT, Gefeller O, Aronsky D, Leong TY, Sarkar IN, Bergemann D, Lindberg DAB, van Bommel JH, Haux R. The birth and evolution of a discipline devoted to information in biomedicine and health care. As reflected in its longest running journal. *Methods Inf. Med.* 2011;50(6):491-507. doi:10.3414/ME11-06-0001.
34. Stiler W, Lindberg DAB, eds. *Computers in Life Science Research*. New York: Springer Science+Business Media; 1974:272. doi:10.1007/9781-1-4757-0546-1.
35. Lindberg DAB. *The Growth of Medical Information Systems in the United States*. Lexington: D. C. Heath and Company, Lexington Books; 1979:194.
36. Wortsman P. Alumni Profile: Donald A.B. Lindberg: A digital pioneer at the National Library of Medicine. *J. Coll. Physicians Surg. Columbia Univ.* 1998;18(3). Available at: http://www.cumc.columbia.edu/psjournal/archive/archives/jour_v18no3/profile.html. Accessed March 10, 2015.
37. Miller named Lindberg Chair; Lindberg delivers talk as part of Eskin Library Celebration. Report. *Vanderbilt Univ. Med. Center's Wkly. Newsp.* 2004. Available at: <http://www.mc.vanderbilt.edu:8080/reporter/index.html?ID=3575>. Accessed March 10, 2015.
38. Masys DR. Presentation of the Morris F. Collen Award to Donald A. B. Lindberg, MD. *J. Am. Med. Inform. Assoc.* 1998;5(2):214-6. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=61292&tool=pmcentrez&rendertype=abstract>. Accessed September 10, 2014.
39. Research!America. Donald Lindberg, MD, accepts the 2012 Geoffrey Beene Builders of Science Award. 2012. Available at: <https://www.youtube.com/watch?v=hLI7Tg704hE>. Accessed March 10, 2015.
40. Schotté O. Oscar Schotté Biology Research Materials, 1949-1957. *Amherst Coll. Arch. Spec. Collect.* 2004. Available at: <http://asteria.fivecolleges.edu/findaids/amherst/ma225.html>. Accessed March 5, 2015.
41. Schotté O, Lindberg DAB. Effect of xenoplastic adrenal transplants upon limb regeneration in normal and hypophysectomized newts (*Triturus viridescens*). *Proc. Soc. Exp. Biol. Med.* 1954;87(1):26-9. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/13224666>. Accessed March 5, 2015.

42. Lindberg DAB, Lucas F V, Sheagren J, Malm JR. Silicone embolization during clinical and experimental heart surgery employing a bubble oxygenator. *Am. J. Pathol.* 1961;39:129-44. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1942449&tool=pmcentrez&rendertype=abstract>. Accessed March 5, 2015.
43. Columbia University Department of Microbiology & Immunology. The Harry M. Rose Memorial Lecture in Infectious Diseases. Available at: <http://www.microbiology.columbia.edu/seminars/roselecture.html>. Accessed March 12, 2015.
44. Lindberg DA, Reese G. Automatic measurement and computer processing of bacterial growth data. *Biomed. Sci. Instrum.* 1963;1:11-20. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/14173137>. Accessed March 10, 2015.
45. Lindberg DA, Reese GR, Buck C. Computer generated hospital diagnosis file. *Mo. Med.* 1964;61:581-2 PASSIM. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/14217491>. Accessed March 10, 2015.
46. Buck CR, Reese GR, Lindberg DA. A general technique for computer processing of coded patient diagnoses. *Mo. Med.* 1966;63(4):276-9 passim. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/5946295>. Accessed March 10, 2015.
47. Lindberg DA. Electronic processing and transmission of clinical laboratory data. *Mo. Med.* 1965;62:296-302. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/14263628>. Accessed March 10, 2015.
48. Lindberg DA. Symposium on information science. VII. Electronic reporting, processing, and retrieval of clinical laboratory data. *Bacteriol. Rev.* 1965;29(4):554-9. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=441307&tool=pmcentrez&rendertype=abstract>. Accessed March 10, 2015.
49. Lindberg DA. Electronic retrieval of clinical data. *J. Med. Educ.* 1965;40:753-9. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/14346746>. Accessed March 10, 2015.
50. Garten S, Mengel CE, Stewart WE, Lindberg DA. A computer-based drug information system. *Mo. Med.* 1974;71(4):183-6. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/4820441>. Accessed March 10, 2015.
51. Lindberg DA. Electronic processing of laboratory data: analysis of bacteriology findings. *Am. J. Med. Technol.* 1966;32(5):333-9. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/5341330>. Accessed March 6, 2015.
52. Lucas F V, Lindberg DA, Van Peenen HJ, Senhauser DA. Processing of laboratory data. *Biomed. Sci. Instrum.* 1967;3:171-9. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/5582601>. Accessed March 6, 2015.
53. Lindberg DA. Collection, evaluation, and transmission of hospital laboratory data. *Methods Inf. Med.* 1967;6(3):97-107. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/5611833>. Accessed March 10, 2015.
54. Profiles in Science: The Michael E. DeBakey Papers. Available at: <http://profiles.nlm.nih.gov/ps/retrieve/Collection/CID/FJ>. Accessed March 6, 2015.
55. Profiles in Science: The Joshua Lederberg Papers. Available at: <http://profiles.nlm.nih.gov/ps/retrieve/Collection/CID/BB>. Accessed March 6, 2015.
56. Gaston LW, Lindberg DA, Vanker AD, Kingsland L. AI/COAG, a knowledge-based surrogate for the human hemostasis expert. *Mo. Med.* 1983;80(4):185-8. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/6855742>. Accessed March 6, 2015.
57. Kingsland LC, Lindberg DA, Sharp GC. AI/RHEUM. A consultant system for rheumatology. *J. Med. Syst.* 1983;7(3):221-7. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/6352842>. Accessed March 6, 2015.
58. Kingsland LC, Lindberg DA, Sharp GC. Anatomy of a knowledge-based consultant system: AI/RHEUM. *MD. Comput.* 1986;3(5):18-26. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/3537610>. Accessed March 6, 2015.
59. Walsh TR, Lindberg DA, Klink EJ, Sharp GC. Computer-assisted Bayesian diagnosis of connective tissue diseases. *Methods Inf. Med.* 1981;20(1):19-23. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/7012541>. Accessed March 6, 2015.
60. Davies NE, Huth EJ, Martin M, Cummings and the National Library of Medicine. *Ann. Intern. Med.* 1983;99(6):860. doi:10.7326/0003-4819-99-6-860.
61. Lindberg DA. The.nlm and Grateful Med: promise, public health, and policy. *Public Health Rep.* 1996;111(6):552-5. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1381909&tool=pmcentrez&rendertype=abstract>. Accessed March 10, 2015.
62. Kingsland L, Graham D. Internet Grateful Med: Making a Good Thing Better. *NIH Catal.* 1996;4(3). Available at: <http://www.nih.gov/catalyst/back/96.05/internet.html>. Accessed March 9, 2015.
63. Lindberg DA. Integrated Academic Information Management Systems (IAIMS). Part I. The IAIMS initiatives of.nlm. Institutional planning for advanced information services. *J. Am. Soc. Inf. Sci.* 1988;39(2):105-6. doi:10.1002/(SICI)1097-4571(198803)39:2<105::AID-ASI7>3.0.CO;2-L.
64. Matheson NW, Cooper JA. Academic information in the academic health sciences center. Roles for the library in information management. *J. Med. Educ.* 1982;57(10 Pt 2):1-93. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/6750129>. Accessed September 10, 2014.
65. Morantz-Sanchez RM, Pomerleau CS, Fenichel C, eds. *In Her Own Words: Oral Histories of Women Physicians*. Westport, CT: Greenwood Publishing Group; 1982:284. Available at: <https://books.google.com/books?id=HNA4-3IQ1QEC&pgis=1>. Accessed March 16, 2015.

66. Matheson NW, John A. D. Cooper, M.D., 1909–2002. *J. Med. Libr. Assoc.* 2002;90(3):364. Available at: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC116423/>. Accessed March 16, 2015.
67. West RT. IAIMS: an interview with Dick West. Integrated Advanced Information Management Systems. Interview by Joan S Ash and Frances E Johnson. *J. Am. Med. Inform. Assoc.* 1999;6(6):447-56. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=61388&tool=pmcentrez&rendertype=abstract>. Accessed September 16, 2014.
68. Lindberg DA, Humphreys BL, McCray AT. The Unified Medical Language System. *Methods Inf. Med.* 1993;32(4):281-91. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/8412823>. Accessed September 10, 2014.
69. Humphreys BL, Lindberg DA. The UMLS project: making the conceptual connection between users and the information they need. *Bull. Med. Libr. Assoc.* 1993;81(2):170-7. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=225759&tool=pmcentrez&rendertype=abstract>. Accessed March 10, 2015.
70. Humphreys BL, Lindberg DA, Schoolman HM, Barnett GO. The Unified Medical Language System: an informatics research collaboration. *J. Am. Med. Inform. Assoc.* 1998;5(1):1-11. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=61271&tool=pmcentrez&rendertype=abstract>. Accessed February 20, 2015.
71. U.S. National Library of Medicine. Former NLM Deputy Director for Research and Education, Harold M. Schoolman, Dies. *NLM Focus.* 2009. Available at: http://infocus.nlm.nih.gov/2009/09/01/harold_m_schoolman_md_former_n/. Accessed March 9, 2015.
72. Arenales D, Humphreys B. NLM Associate Director, Lois Ann Colaiani Retires After Nearly 18 Distinguished Years. The Legend of Library Operations, Lois Ann Colaiani, Puts Her Career on the Shelf. 1998. Available at: <http://www.nlm.nih.gov/news/lac.html>. Accessed March 16, 2015.
73. Smith K. A Brief History of NCBI's Formation and Growth. In: *The NCBI Handbook* [Internet]. 2nd ed. National Center for Biotechnology Information (US); 2013. Available at: <http://www.ncbi.nlm.nih.gov/books/NBK148949/>. Accessed March 16, 2015.
74. Lindberg DAB, Humphreys BL. "You have to be there": twenty-five years of SCAMC/AMIA symposia. *J. Am. Med. Inform. Assoc.* 2002;9(4):332-45. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=346621&tool=pmcentrez&rendertype=abstract>. Accessed March 10, 2015.
75. Nina Matheson, AHIP, FMLA Oral History Summary. *MLANET*. Available at: <https://www.mlanet.org/node/10556>. Accessed March 16, 2015.
76. Lindberg DA. A statewide Medical Information System. *Comput. Biomed. Res.* 1970;3(5):453-63. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/5500369>. Accessed March 10, 2015.
77. National Institutes of Health Department of Health and Human Services. Working Group on Public Participation in NIH Activities; Notice of Meeting.; 1998:48741.
78. Congressional Record--Senate. NIH Earmarks.; 1998:S12229-S12230.
79. National Institutes of Health. Historical Documents Related to the Council of Public Representatives. NIH Free. Inf. Act Off. 2012. Available at: <http://www.nih.gov/icd/od/foia/annualreports/COPR/>. Accessed March 10, 2015.
80. Lindberg DAB, Howe SE. "My flying machine was out of order". *Trans. Am. Clin. Climatol. Assoc.* 2009;120:99-111. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2744555&tool=pmcentrez&rendertype=abstract>. Accessed March 10, 2015.
81. Bourne CP, Hahn TB. *A History of Online Information Services, 1963-1976*. MIT Press; 2003. Available at: <https://books.google.com/books?id=LTTvmUU8rskC&pgis=1>. Accessed March 9, 2015.
82. Maxam AM. Sequencing the DNA of recombinant chromosomes. *Fed. Proc.* 1980;39(10):2830-6. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/6157574>. Accessed March 16, 2015.
83. Modlin M. NLM Retiree Howard Mourned. *NIH Rec.* 2002. Available at: http://nihrecord.nih.gov/newsletters/10_15_2002/obits.htm. Accessed March 4, 2015.
84. Ostell JM. Jim Ostell on GenInfo Backbone and ASN.1.; 1990. Available at: <https://www.youtube.com/watch?v=4Eysn96nyuE>. Accessed March 9, 2015.
85. Kotzin S, McCarn DB, McCarn G, Burket R, Katter R, Kenton D, Port T. Remembering ELHILL. *NLM Tech. Bull.* 1999. Available at: https://www.nlm.nih.gov/pubs/techbull/ja99/ja99_remember.html. Accessed March 10, 2015.
86. Lindberg DA. Internet access to the National Library of Medicine. *Eff. Clin. Pract.* 2000;3(5):256-60. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/11185333>. Accessed March 10, 2015.
87. Kingsland LC. The computer fact bank. *Mo. Med.* 1968;65(9):734-5 passim. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/5695460>. Accessed March 9, 2015.
88. National Center for Biotechnology Information. (NCBI). Genetic Testing Registry. Available at: <http://www.ncbi.nlm.nih.gov/gtr/>. Accessed March 9, 2015.