

October 26, 2011

I am delighted to be able to add some remarks to the celebration of this Health Sciences Library and also to honor Dr. Lindberg. Deb asked me to do several things as part of this celebration. She asked me to tell you something about Don's Informatics career while he was at MU and before he went to the NLM. She asked me to give some anecdotes and memories about working with Don. And she asked me to focus on how both Don and I had worked with the Health Sciences Library over the years. And how the Department of Health Management and Informatics was created. That is an almost forty year span, so I will be rather spotty in my history.

Let me start with the first time I met Don Lindberg. I interviewed with Don for a postdoctoral fellowship in the area of Medical Information Sciences. These fellowships were funded by the NLM as part of a training grant. I arrived as a postdoctoral fellow in 1976. The main reason I took this fellowship was that I wanted something interesting that was in Columbia, MO. I had gotten married during my last year in graduate school at the University of Wisconsin and wanted to get a position in Columbia because my husband was here. Medical Information Sciences was very, very different from my basic science, wet bench laboratory work in experimental population genetics. But Don said that my background of mathematics, probability and statistics, computing, and genetics would be great for this new field that was just developing. I said, "I don't know what this field is". He said, "Why don't you try it?" So I took a leap of faith, drank the Kool-aid, and tried out Medical Information Sciences. It took about a year before I figured out what was really going on and caught up with the change in culture from basic science to what became Biomedical Informatics.

Medical Information Sciences was well established at MU when I arrived because Don Lindberg had built this program for 16 years by then. He was hired

- Hired as a Pathologist in 1960. Brought a grant with him when he was hired. He was hired to be responsible for the medical operation of the clinical laboratory.
- He soon decided that a computer would help him with his research and started working with mathematical models of bacterial growth. He was investigating antibiotic sensitivity of gram-negative pathogenic bacteria. He then decided to look at real patient data to consider the choice of antibiotics for treatment of infections. And he decided that computers would help him with the medical operation of the clinical laboratory itself, not just his research.
- He began to develop the system that became the first computer-based clinical laboratory system. The system (called WURST) captured data from all patient care hospital laboratories and delivered printed reports to all wards and clinics. He used punch cards and teletypes and then computer terminals.
 - The system was developed to detect and prevent clinical chemistry laboratory errors.
 - He developed a system used for the automatic recognition of clinical disease patterns.
 - He pioneered the **use of large data sets** to help with setting normal laboratory values, using 12,000 cases where the previous values were set with 100 total values.
- He used the patterns of symptoms and test results along with statistical information on prevalence and incidence to create one of the first computer-assisted diagnostic systems, called **CONSIDER**. This was used primarily for teaching medical students how to formulate differential diagnoses.
- He combined numerous departmental information systems into a “complete” hospital information system. In 1968 he wrote a book titled, “**Computers in Medical Care**” to consider the major issues related to electronic medical records. Almost all of the major issues that would arise over the next decades and the major benefits that might accrue were anticipated.

- Between 1960 and 1968 he was instrumental in revolutionizing the way pathology laboratories operated. He developed the field of clinical computing as an academic field. The ultimate result was that every pathology laboratory operates a clinical computing system and built on the principles that Don developed. And he did this at a time when there were no Departments of Computer Science anywhere. And note that MU did not receive any royalty income from any pathology systems anywhere in the world because ideas such as these were not considered patentable at the time.
- Other grants and projects:
 - **Regional Medical Program** – late 60's and early 70's – demonstrated the value of remote consultation for ECG interpretation, diagnostic assistance to primary care providers, and provision of information to patients. I have seen video footage of Dean Vernon Wilson flying around Missouri in his airplane, and one of the places he flew was a little town in Phelps County, South of Rolla, where some of the remote consultation systems were being developed.
 - He began a postdoctoral training program in Medical Informatics in the early 1970's. This was developed further with grant support from the US Army Research and Development Command and then the NIH/NLM (in 1975). These were the first NLM-sponsored training grants that were given.
 - In the late 1970's, he moved beyond the CONSIDER program and into the world of **artificial intelligence and expert systems**. The AI/RHEUM series of systems worked from diagnostic criteria to assist in diagnosis of arthritis (AI/RHEUM working with Gordon Sharp), dermatology (AI/DERM working with Phil Anderson), coagulation disorders (AI/COAG working with Monty Gaston), and deaf-blind syndromes (AI/GEN working with Sandy Davenport and me). Working with Stanford and Rutgers Universities, he helped to lay the groundwork for diagnostic decision support systems which have now been integrated into electronic medical records.

- He worked with the College of Engineering to develop the National Special Emphasis Center on Health Care Technology (HCTC), as part of a national consortium of Centers for Health Services Research. I remember especially Jay Goldman from Industrial Engineering and Sam Dwyer from Bioengineering who were working on projects as part of the HCTC. Don was the PI of the HCTC. He had just received word of this major Center grant when I arrived as a postdoctoral fellow.
 - Played a major role in the development of the field of Medical Informatics (now called Biomedical Informatics) and its recognition as an academic discipline, but that will be discussed in more detail by Mark Frisse.
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Anecdotes and memories of working with Don Lindberg at MU:

As a postdoctoral fellow, I worked within the milieu of the National Center for Healthcare Technology (HCTC). We had several grant site visits – and I learned so much about how to organize and present to a site visit team. There were many projects within the HCTC, including evaluations of multiphasic laboratory screening, working with Dr. Gwil Lodwig on radiology information systems and bone disorders, pharmacy information systems, device development with the biomedical engineers, process re-engineering with the industrial engineers, and technology evaluation such as one conducted on the newly arriving CT scanners.

I also helped with the special collection library that was developed for the HCTC, starting to build a micro-computer based system to manage and retrieve the items in the collection. I learned about MeSH, indexing, database management systems, and retrieval strategies. I had my first Informatics grant experience related to this library collection system.

We were a test site for MEDIS – an offshoot of LEXIS (for law literature) and NEXIS (for new stories) but focused on the medical domain. We were doing full text searches of medical literature and comparing it to retrieval done with the librarians using the newly developed Medline system. Of

course, LEXIS and NEXIS flourished but MEDIS never really took hold, perhaps because of the power and availability of Medline and the NLM.

I spent 2 years as a postdoctoral fellow with Don Lindberg and began to wonder in what capacity I might become a faculty member at MU and continue this work. There were no faculty slots for people focusing on Medical Information Sciences. I could not find any medical genetics faculty at MU and knew that PhD faculty could play a role if they had clinical fellowship training. So I applied for and obtained a 2-year clinical medical genetics postdoctoral fellowship at the University of California, San Francisco. UCSF Medical Genetics had decided not to have any more PhD postdocs – those people just needed to get an MD – but they decided to make an exception for me because I had a postdoc in Medical Information Sciences already. My main project at UCSF was to create a system to computerize their clinical genetics data to assist not only with considerations of which provider saw which patient in what location but also with the patient characteristics and how to consider interesting patterns of symptoms. That training led to me being Board Certified as a PhD Medical Geneticist.

Don helped me to get a faculty position at MU in 1980. This was in conjunction with Judy Miles who had started the Division of Medical Genetics and Giulio Barbero, the Department Chair for Child Health. I was hired in the Medical Genetics Division of the Department of Child Health and was in that department for 20 years. In those early years, I saw patients in clinic, did consults, and outreach clinics, covered emergencies in the newborn nursery, and worked with Drs. Judith Miles and Sandra Davenport to get the Medical Genetics Unit up and running. In the meantime, I had 50% time devoted to my research in Medical Informatics.

I worked with the startup of the AI/RHEUM series of projects, developing AI/GEN as a new faculty member, and later moving that into AI/LEARN as part of a grant with the Arthritis Center. I got my first NIH grant to develop AI/GEN, working with Sandy Davenport as the genetics expert and with Don Lindberg as a co-investigator. Don started recommending me to go on grant site visits and be part of a review team. This led to being on the NLM grant

review study section where I reviewed both Informatics and Library resources grants.

For the research work, we worked with Rutgers and Stanford University faculty and with software on those Universities' computer systems via dial-up 24-baud modems and weekly conference calls. The local work was done first on Digital Equipment VAX minicomputers, then on Charles River Data Systems microcomputers with 8 in floppy drives. We were working with desktop microcomputers before I went to San Francisco, but I was in San Francisco during the dawn of the personal computer era and Steve Jobs building the first Apple computer in his garage, so it was a very interesting time. At UCSF, I used a combination of a personal computer front-end to a mainframe database to cut costs and have more control of the input. Part of that work involved taking the machines apart, switching components and flipping dip switches to configure the machines, working with cassette tapes for input and storage, and fixing various programming problems by correcting the program in hexadecimal. When I got back from San Francisco, almost all of the work was done with microcomputers from then on.

And we always worked with the Health Sciences Library.

Don served on the planning committee for the new health sciences library. He always wanted a space in the library where he could demonstrate various software that could be used for diagnostic decision support or other new developments – he called it the “showcase”. He also lobbied for a floor in the Health Sciences Library that would be used for the Medical Information Sciences Group. There was no money for that extra floor, although there were provisions within the architectural diagrams that would allow an extra floor to be built at some point in the future. Unfortunately the change in the building codes because of the analyses from the New Madrid fault made that impossible.

After all of that planning, Don was hired away to the National Library of Medicine before the library opened.

He recommended me and I was selected by Dean Bradshaw to continue to operate the Medical Information Sciences Group after Don left for the NLM. Dean Bradshaw said that he wanted me to focus the energies of the group on the AAMC's GPEP report (general professional education of physicians) and help to integrate informatics concepts and competencies into the curriculum of the medical students. (Of course, Don had been a co-author of the AAMC's GPEP Report, especially the Informatics in the curriculum part.) I told Dean Bradshaw that I would be most pleased to concentrate on that work but it would be difficult to do because there was not a computing facility for the medical students to use and the MU mainframe did not seem suitable for that purpose. So he gave me the funds to create a microcomputer lab and get the work underway. And he told me to set up the computer lab within the first floor of the health sciences library – and that started a long relationship working with the library. Dean Schmidt was the Director of the Library at the time.

I set up the space in two parts: (1) a free-standing microcomputer laboratory (IBM PCs), and (2) a set of more specialized computers with software that was also more specialized. This accomplished Don's "showcase" idea but also allowed us to teach various things to the medical school students and nursing school students. We had to start by teaching very basic concepts to the students. But we rapidly progressed to such items as teaching them how to search MEDLINE using Grateful Med. I got a special deal with the NLM to give each medical student a free code to use Grateful Med to search MEDLINE during their medical school coursework – this was part of my teaching them about medical genetics. Then I studied the audit trails of their search behavior and wrote several articles. MU was the first place to have such experiences within their curriculum. I worked with the librarians of the HSL (especially Emma Jean McKinin and Diane Johnson) to also have classes to teach the faculty to search MEDLINE. Teaching the faculty was somewhat more slow going. But everything changed in the mid-90s when the NLM gave free access to their bibliographic files to everyone via the internet.

I worked on several library and information science research projects that were concentrated on full text searching of literature databases. These projects were led by Dr. Mary Ellen Sievert, a professor in the School of Library and Information Sciences, and also involved Diane Johnson and Emma Jean McKinin. We involved the faculty from the health sciences schools to help judge whether various retrieval strategies were good, better or best. This research team was the leading full-text research team in the US for many years, won several awards for best journal paper of the year in information sciences. And Dr. Sievert was much in demand from various software companies and also the NIH as they moved into the full text searching world. All of this before the Internet hit the big time. But this research teams' ideas were woven into many of the early Internet search engines.

I also worked with the Health Sciences Library on a series of grants that lasted 8 years and was called IAIMS. These were the Integrated Advanced Information Management Systems grants. I was the PI and Dean Schmidt, the Director of the Library, was the co-PI. We had a planning grant in 1994 which created a strategic plan for the whole health sciences center for integrated advanced IT. Linda Cooperstock was a key professional staff member to this work. Several things came immediately from the Strategic Plan:

- Dean Bryant created an Associate Dean and CIO position in 1994 and asked me to serve in that position. I worked closely with Bob Churchill who was the Vice Dean at the time.
- We created a strategic plan specifically for the clinical IT enterprise in 1995
- We received an IAIMS implementation grant in 1996.

These were our main priorities:

- Focus on an electronic health care record because it was strategic for our future and could be used to boost all academic missions as well as the health system.
- Create an appropriate IT organizational structure
- Extend/enhance internet access to all

- Acquire/develop advanced tools for success including a site license to a relational database system
- (unspoken) – get the institution successfully through the Year 2k

The main impact of IAIMS at MU:

- Integrated vision of telemedicine for rural health care and access
- Business process reengineering focus for IT enabled processes
- Recognition of IT as a strategic resource for HSC success
- Major reorganization of the IT units
- Creation of the Office of Clinical Outcomes and Medical Management
- Create an Office for Information Systems Security
- Created the Digital Media Center for educational projects
- Created the basic infrastructure to be successful with an EMR and form a partnership with the Cerner Corporation that has won some awards and done some very interesting work.
- Creation of the Department of Health Management and Informatics in 1997

The other key event that happened in 1997 was that Dean Schmidt retired and Deb Ward was hired to be Director of the J. Otto Lottes Library. Before he retired, Dean Schmidt was instrumental in developing the MERLIN library system for MU and helping to organize the Missouri Library system consortium called Mobius.

Deb – I think I have now done what you asked: Talk about Don’s Informatics work at MU, talk about the works of Informatics joint with the Health Sciences Library, and bring it to the point that the Department of Health Management and Informatics was created. I have brought things from 1960 until 1997, a span of almost 40 years. Don Lindberg was the key force in setting the intellectual foundation and institutional milieu for all of this to be successful.

Now I will turn the podium over the Don Lindberg. Even though I have focused to this point on his work during the 24 years he was at MU, his main national and international impact has been during the years that he has served as the Director of the National Library of Medicine (from 1984 to the present), the Director of the US High Performance and Communications Initiative (from 1991 through 1998) and the US Representative to the G7 Global Health Initiative Project. He has used the influential position of the NLM to create the National Center for Biotechnology Information and leveraged the Internet to fundamentally change the way that biomedical scientists work. Through PubMed, MEDLINE +, Genetics Home Reference, and many more NLM services, he has also changed the way the whole world accesses information about biomedicine, clinical care, and including consumer health issues. His programs have been responsible for training the vast majority of the people in the field of biomedical informatics, reported by Consumer Reports to be one of the top five hottest professions in the US today.

Please help me welcome Dr. Donald Lindberg.