

International Medical Informatics and the Transformation of Healthcare



Casimir A. Kulikowski, Editor-in-Chief

George I. Mihalas, Associate Editor-in-Chief

Robert A. Greenes, Editor

Hyeoun-Ae Park, Editor

Valerio Yáclubsohn, Editor

HIM&CC
ISSN 1485-7375

Copyright, 2021 by Healthcare Computing & Communications Canada for IMIA, The International
Medical Informatics Association
©HIM&CC & IMIA

Ted Shortliffe



E.H. Shortliffe, MD, PhD,
MACP, FACMI

Adjunct Professor of Biomedical Informatics at Columbia and Arizona State Universities (current)
Professor of Biomedical Informatics at Stanford (1979-2000), Columbia (2000-2007) and Arizona State Universities (2007-2018)
Professor of Medicine, Stanford University (1979-2000)
President and CEO, AMIA (2009-2012)
Editor-in-Chief, *Journal of Biomedical Informatics* (2001-2020)
Editor, *Biomedical Informatics* (textbook), 5 editions since 1990

I was born in Western Canada (Edmonton, Alberta) where my father was a newly trained physician and my mother a high school English teacher. After my father obtained additional training in healthcare administration at the University of Toronto (while the rest of the family stayed in Edmonton and I started first grade), Dad was recruited to

a position at Hartford Hospital in Connecticut and we all moved to the US in 1954 and became citizens in the early 1960s.

It was natural that I would be drawn to medicine. An annual ritual was Dad's visit to the hospital wards in Hartford on Christmas Day, where he would greet the staff members who were working on the holiday. I frequently joined him on these visits and remember being excited by the healthcare environment and impressed by the dedication of the physicians, house staff, nurses, and support staff who were working in good spirits on a major holiday. By the time I served as a hospital volunteer in high school (I attended a prep school near Hartford now known as Loomis-Chaffee), I was sure that I would pursue a career in medicine.

I headed to Harvard College in 1966 (after a year as an exchange student in the UK from 1965-66) and, since Harvard did not offer a pre-med major, leveraged my interest in math and science to declare as a physics major. But then I discovered computers (which in those days were not yet available in the home or even in high school). I quickly learned that my interest in computer science eclipsed my interest in physics, and I took as many computer courses as I could while still meeting my other course distribution requirements. Since there was no Harvard computer science department or major at that time, I changed my undergraduate major to applied mathematics, which would allow me to take more computing classes.

All this led to my realization that I had a tough decision: pursue medical school as I had planned for years, or apply to graduate school in computer science. The problem was that I could not decide and really wanted to do both. It was my undergraduate advisor, William Bossert, who knew about the Laboratory for Computer Science (LCS) at Massachusetts General Hospital (MGH) and suggested that I make contact with the LCS director, Dr Octo Barnett, to see if I could get a student programming position and learn about what was happening at the intersection of medicine and computer science. To this day I wonder what would have happened if I had not received this advice!

At MGH in 1968 I met with Octo Barnett, who was engaged with others in the development of the MUMPS programming language, with many application systems being implemented for the hospital. He gave me a programming test that required me to learn MUMPS quickly and then to plot (on an all-caps Model 33 teletype!) a blood pressure curve for a patient, based on systolic and diastolic pressures stored in a MUMPS

database. I must have passed this test adequately since he then agreed to give me a part-time programming position and assigned me to work on the doctoral research project of a young physician who had recently graduated from Harvard Medical School and was now doing a PhD dissertation project that was, essentially, an electronic medical record system for the MGH hypertension clinic. Thus began my longstanding personal and professional relationship with Dr. Robert Greenes, who was among the first two or three physicians to get doctoral training in computer science. I worked closely with Bob for two years and was thrilled when he acknowledged me by name when he published a *New England Journal of Medicine* paper on his system.

Having become committed to continuing in both medicine and computer science, I needed to find a medical school that would allow me to pursue both types of courses – hopefully simultaneously. In 1970 this was a distinctly unusual idea, and many schools questioned why I would even want to study both fields. I also applied to Medical Scientist Training Programs (MSTP) at several schools, since they were designed to train MD/PhDs and at least some of the programs were willing to consider PhD training in engineering disciplines rather than traditional wet-bench fields.

Although I was accepted into MSTP programs at several schools (notably Yale and Washington University St Louis), I ultimately decided to accept the medical school offer at Stanford University. They did not entertain MSTP applications until a student was already in the first year of medical school, so I took a chance in turning down other programs to go to a school where my MSTP acceptance was not guaranteed. However, Stanford had a great appeal. First, it offered remarkable flexibility in how one could get MD training – notably a sole requirement that a student pass all individual sections of the National Board Exam (Part 1) at the end of the second year (and Part 2 after clerkships). There was no required classroom curriculum and students could in theory elect to skip a course if they could pass the boards in that field through self-study. Furthermore, the medical school was literally across the street from engineering and computer science, and the university classes and medical school classes were on the same schedule. This meant I could hop on a bicycle and move between medical school and computer science classes without difficulty. In addition, the computing industry was evolving quickly in the Stanford area, with Hewlett Packard and the Xerox Palo Alto Research Center (PARC) dominating at that time (although the “Silicon Valley” phrase had not yet been coined).

So I took a chance, went to Stanford, and immediately started taking some computer science classes while I was a medical student. The first one was “Computers and Thought”, which intrigued me because it seemed inherently to combine the medical and computing fields. Little did I know that this course would change the direction of my career; it was an introductory course in artificial intelligence, which fascinated me and helped to define my own subsequent research interests. Of course I mostly took med school courses, and I got a programming position on a clinical computing project directed by our then-chief of clinical pharmacology, Dr. Stanley Cohen. Stan was a physician scientist whose work in genetics ultimately led to the famous Cohen-Boyer patent for gene splicing, and Stan went on to become the Chair of Genetics. But at this time he was still clinically active and he sponsored my application for the Stanford MSTP program, arguing cogently that medical computing, properly pursued, could be as scientific as the traditional bench sciences that dominated in the medical school at that time. Also influential was our Chair of Genetics, Joshua Lederberg, already a Nobel Laureate in Medicine, who supported advanced computing and ultimately brought the NIH SUMEX-AIM computer system to Stanford, which was the technical base for my own dissertation

work on the MYCIN system. I completed medical school courses in the first two years, passed my boards, and then did research work with Stan Cohen as my dissertation advisor. My PhD was completed in October 1975 and my MD in 1976. Also a crucial contributor to my work, and a friend and colleague to this day, was Dr. Bruce Buchanan, a research scientist in the computer science department who had been recruited to Stanford by Josh Lederberg and computer scientist Edward Feigenbaum.

Subsequently I did an internship in medicine back at MGH, returned to Stanford for junior and senior residency, and then joined the Stanford faculty in internal medicine in 1979. By 1982 I had started a graduate training program for both MS and PhD students, fashioned after the informatics curriculum that I had devised for my own PhD. That program was supported by an NLM training grant starting in 1984 and continues to the present. It started under the name “medical information sciences” but, as the informatics term was popularized and the biological applications of the field became prevalent, today it is known as “biomedical informatics”.

During my 21 years on the Stanford faculty, I continued an active research program focused on decision-support systems and AI. The rapid changes in computing technology presented us with processing, display, and interactive capabilities that would have been unthinkable when I began in the field. Accordingly, our work on Oncocin, T-Helper, and InterMed all explored the evolving technologies (graphical workstations and LISP machines, the commercialization of the Internet, touch screen tablets, and local area networking) while focusing on developing new types of usable and acceptable interactive systems to assist with clinical decision making.

This was also the period when a number of young and adventurous students came to Stanford to get informatics graduate degrees. They all had a pioneering spirit and commitment to the field, since the discipline was new, largely unrecognized in the broader medical community, and focused on future potential more than on current commercial systems. The passion of those students, coupled with their intellect and creativity, led to a marvelous intellectual environment, and I often look back and observe that the training we offered, and the students that we attracted, likely constituted a greater contribution to the field than did any of the individual research projects that we undertook. Many of those trainees are now well-known leaders in the field, and they are scattered around the country and internationally.

I assumed the PI-ship of the SUMEX-AIM resource for several years and collaborated with colleagues to create and fund successfully a follow-on resource known as the Center for Advanced Medical Informatics at Stanford (CAMIS). With additional responsibilities in the Stanford dean’s office, where I oversaw computing resources for the medical school, and my duties as Chief of General Internal Medicine in the Department of Medicine, this was a particularly busy period. My time for research work was too often compromised by all the other work I was doing, some of which was on the national scene rather than at Stanford itself.

I started the new century by accepting a position as Chair of the Department of Biomedical Informatics at Columbia University’s College of Physicians and Surgeons. This also allowed me to return to my roots on the East coast, where I have thoroughly enjoyed my new home base in Manhattan. We redesigned the training program there and attracted another cadre of superb students, many of whom are now well-known informatics leaders. Unlike the Stanford program, the program at Columbia had faculty who were deeply involved with the day-to-day creation and management of clinical systems, working closely with the hospital and outpatient clinic information technology groups. This allowed me to get more involved with hospital systems and their strategic

planning. Also while I was at Columbia, I was enticed to take over as Editor-in-Chief of the former *Computers and Biomedical Research*, which we rebranded as the *Journal of Biomedical Informatics*. That journal focuses on papers that introduce novel generalizable informatics methodologies. It is recognized as among the top journals in the field and we are celebrating its 20th anniversary in 2020.

I did take a break from New York from 2007-2009 (when I was founding dean of the new Phoenix campus of the University of Arizona College of Medicine, with a cross appointment at Arizona State University—ASU) and from 2009-2012 (when I followed Don Detmer as the second full-time President and CEO of the American Medical Informatics Association). Since then I have returned to New York and, avoiding the notion of retirement, have taken adjunct teaching appointments at both Columbia and ASU while editing the journal and my textbook of Biomedical Informatics, soon to be released in its 5th edition. I am an advisor on several boards, have been active at the National Academy of Medicine (where I have led several studies over the years), do some consulting to industry, and travel extensively to give talks and visit informatics programs around the world.

Dating my entry into the field to 1968 at MGH, I now look back on over a half-century participating in the evolution of biomedical informatics as a young discipline and as an applied field that is now being widely embraced in academia, health care, and the health information technology industry. There is still much to be done, and one worries about some of the hype that one hears about the field and its presumed short-term impact (especially in the areas of AI and machine learning), but it has been a wonderful ride and, in the years ahead, I will enjoy continuing to watch and participate in the field's progress and support for health and health care.



Donald A.B. Lindberg and Ted Shortliffe in 1983 at the Aiguille du Midi (3842m) cable-car station beneath the peak of Mont-Blanc

