In Memoriam: Robert Steven Ledley, DDS, MS (Physics), 1926-2012

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Robert S. Ledley, one of the founding fathers of the field of medical decision making and the man who applied computer science to medical judgment and diagnosis, died July 24, 2012, after a prolonged struggle with Alzheimer’s. Our community, as well as the medical field as a whole, has lost a pioneering genius.

Bob Ledley’s legacy will live on through his magnum opus “Reasoning Foundations of Medical Diagnosis,” coauthored with Lee B. Lusted, MD, FACMI. Lee Lusted was one of the founders of the Society for Medical Decision Making and the founding editor of Medical Decision Making. In their seminal work, the authors showed how computers could help physicians with diagnoses and even taught medical workers how to use edge-notched cards to create diagnostic databases. Most important, this article addressed decision making under uncertainty and valuing outcomes. Citation analyses have demonstrated that this paper lies at the root of medical decision science. In fact, many readers may recall their introduction to our discipline through this article. We now explore the rest of his talent for technological innovation.

Robert Steven Ledley was born in Flushing Meadows, New York, in 1926. While attending dental school at New York University College (at his parents’ strong behest, so that he could earn a living), he also pursued his interest in physics at Columbia University. He received his DDS in 1948 and his MS in theoretical physics the following year. One of his professors “joked that he was the only physicist who could pull a man’s tooth.” When the Korean War broke out, Ledley volunteered as a First Lieutenant in the US Army Dental Corps; as a result of his background in physics, he was assigned to research prosthetic dental devices at Walter Reed Army Medical Center in Washington, DC. His work optimizing denture fitting based on “angle of chew” earned him an article from the Associated Press titled “Mathematics Used to Keep False Teeth in Place.” After completing his service, Bob served as an investigator at the National Bureau of Standards and Johns Hopkins University and was an associate professor at George Washington University.

While at the National Bureau of Standards, Ledley obtained for his wife (the former Terry Wachtell, a music major whom he convinced to switch to mathematics) a position as a programmer on the Standards Eastern Automatic Computer (SEAC). Bob was fascinated and spent a decade learning to program before using the computer to solve complex problems in his own research. He was an ardent believer in the prowess of computational research: “I had previously realized that although, conceptually, physics equations could be written to describe any biomedical phenomenon, such equations would be so complex that they could not feasibly be solved in closed form. Thus SEAC would be my panacea, because the equations would become tractable to numerical methods of solutions. Or so I truly believed at the time. That was to be my field, application of computers to biomedical problems.” It didn’t take long for Ledley to arrive at a natural starting point—computerizing the diagnostic process. He recalled, “I put together a deck of the McBee keysort cards (the cards with the holes around the margins) for diseases of the tongue. Each card was a disease, and symptoms related to the disease of the card were punched out to the card margin. Then, if needles were pushed through the edge holes...
of the deck of cards corresponding to a selection of symptoms, the cards that dropped would be only those corresponding to diseases having these symptoms. I even made a little device for facilitating the shaking and dropping of the cards, and as I carried the deck and my device around the halls of NBS, it didn’t take the physicists more than a fraction of a second to say to me, ‘Oh, you’re going to automate medical diagnosis, huh?’.”

His proficiency with the computer didn’t remain unnoticed for long—the theoretician and polymath George Gamow invited Ledley to join the RNA Tie Club. This informal but exclusive group of 20 (one for each amino acid) was a forum to explore how DNA coded for proteins and how RNA fit in. Ledley, who was whimsically assigned the title of “Asparagine,” worked closely with Gamow on the faculty of George Washington University to express the nature of DNA as an encoding scheme—specifically, to express DNA as an invariant number for each individual. The work Bob put into developing a computer program for this problem can be found in his paper “Digital Computational Methods in Symbolic Logic, with Examples in Biochemistry.” Once it became apparent that the computation would take more than 1000 years with the most powerful machines of the time, Ledley left the group.

He was then recruited to conduct a survey by the National Research Council’s National Academy of Science. His survey on “current and potential computer use in biology and medicine” was commissioned to help physicians surmount their hesitation to using computers. Science published the results of his survey in 1959, and Ledley’s call for physicians to use the tools available to them was made public. While working on this study, Bob developed his famous collaboration with Lee Lusted, a radiologist and electrical engineer. The two noted great similarities in one another: “We found that we were thinking about similar problems and possible solutions.”

They worked together to find an optimal method for teaching physicians how to use electronic computers, finally arriving at a system that involved weighting data based on importance and source. The numerous papers they contributed to the field were pivotal in determining the direction that biomedical research would take toward the use of computers.

Ledley made it a lifelong goal to promote the use of computers among physicians and biomedical researchers—to this end, in 1960 he founded the National Biomedical Research Foundation. During his 50 years as president of the NBRF, he led the compilation of all known protein sequences, developed a pattern recognition algorithm to identify chromosomes, and developed instruments to measure the efficacy of antibiotics. Bob remained current with developments in biomedical informatics: As recently as 2003, he was one of the creators of the Protein Information Resource, an omnibus digital library of information on proteins useful for genomic and proteomic research.

As expected, Bob was awarded many grants. One particularly large grant from the NIH, however, was never delivered because of budget cuts. Looking elsewhere for money, Ledley found a neurosurgeon who wanted to buy a head scanning machine from Electrical and Musical Industries (EMI). Ledley offered to build a scanner with greater resolution for half the price: his Automatic Computerized Transverse Axial scanner (ACTA) was able to scan the entire body and produced higher quality images than the machine developed by EMI. It was a forerunner of the modern CT scanner. To produce and sell his scanner, Ledley established the Digital Information Science Corp (DISCO). In 1976, DISCO sold the rights to ACTA for $1.5 million and $10 million in research funding.

Developing ACTA landed Dr. Ledley a seat in the Inventors Hall of Fame; he also received the National Medal of Technology and Innovation from President Bill Clinton in 1997 for this work. In 1998, Ledley received the Goldhaber Award from Harvard School of Dental Medicine for his leadership in research. He also received the Morris F. Collen Award for lifetime achievement and contributions to the discipline of medical informatics of the American College of Medical Informatics. Bob was elected to the Institute of Medicine in 1999.

They say a man dies twice: once, when he breathes his last breath, and the second time when his name is uttered for the last time. Bob Ledley may have left us in July 2012, but his inventions, contributions, and ideas are very much alive.

REFERENCES