ALBERT L. BABB

1925–2014

Elected in 1972

"Engineering contributions to the development of artificial kidney systems and medical applications of nuclear energy."

BY BRUCE A. FINLAYSON

ALBERT LESLIE BABB, a central figure in developing the home kidney dialysis unit, died October 22, 2014, at age 88. He was born in Vancouver, British Columbia, on November 7, 1925, and earned a bachelor's of applied science (first class honors) in chemical engineering at the University of British Columbia in Vancouver (1948), and MS (1949) and PhD (1951) degrees from the Department of Chemical Engineering at the University of Illinois.

In 1952 he was appointed assistant professor of chemical engineering at the University of Washington in Seattle with the task of developing a Nuclear Engineering Department. His thesis work had involved mass transfer, and he took summer jobs with General Electric in Richland, Washington (working on separating plutonium and uranium from fission products), and Argonne National Laboratories in Illinois to learn about the nuclear industry. By 1955 the first graduate courses in nuclear engineering at the University of Washington were ready, and in 1965 the Department of Nuclear Engineering was formed with Babb as chair (1965–1981). He was also director of the university's Nuclear Research Laboratory from 1961 to 1973. The laboratory was to play an important role in his accomplishments.

In 1963 Belding Scribner, head of the Division of Nephrology at the University of Washington, had developed a technique for continuous hemodialysis to treat acute kidney failure in individual patients, but the process was costly and labor intensive, limiting the number of patients that could be treated. Wells Moulton, chair of the Chemical Engineering Department, referred him to Dr. Babb, whose experience in mass transfer was an excellent background for understanding the nature of dialysis. In collaboration with Dr. Scribner's medical team, Dr. Babb and a team of engineers (at the Nuclear Research Laboratory) designed a device (dubbed the "monster" by patients and nurses) that safely automated dialysis and could serve several patients at one time while cutting the cost in half. Instead of the previously used sodium bicarbonate, the dialysate was sodium acetate and the device could provide dialysate to five bedside stations simultaneously. Later it was learned that using sodium bicarbonate would have created severe contamination problems in the home dialysis unit that were not a concern with sodium acetate. The unit did, however, use large tanks and was very noisy.

Since there were many more patients than could be accommodated at the Artificial Community Kidney Center, a committee selected those who should be treated, eliminating, for example, those under 16 years of age. Dr. Scribner had been treating a 15-year-old girl who would need dialysis in four months and he asked Dr. Babb if he could design a home unit. While there had been a few examples of a home unit using a batch tank as the dialysate supply system, this approach would not have been acceptable to the selection committee as it would have been construed as circumventing the selection process. Dr. Scribner suggested developing a home dialysis unit as an experimental research project with external funding, a project over which the committee would have no jurisdiction. After learning the girl was the daughter of someone he knew, Dr. Babb carefully thought about the problem and accepted the challenge.

As director of the Nuclear Reactor Laboratories, Dr. Babb had a team of engineers that agreed to work on the project. The constraints were severe: build a system that would remove creatinine and urea and other chemicals in a fail-safe environment without the attendance of nurses and doctors. Dr. Babb took a stopwatch to the university hospital to see how the current system operated; it was very labor intensive and not suitable for an unmonitored system. His design team worked with Dr. Scribner's medical team to establish the design criteria. A central logic unit would provide alarms to protect the patient. The thermal hydraulic system had to mix precise proportions of dialysate and tap water and heat to a precise temperature. Some of the necessary equipment, including gauges and sensors, was not available for standard purchase, but manufacturers provided what was needed and the pumps were quiet enough for home use. A fault-tree analysis estimated the consequences of component failure.

While the engineers at the Nuclear Research Laboratory worked on their design and tests, they established a "dean watch": the dean had been instrumental in getting the laboratory going and frequently brought visitors to see it; when he did, the engineers would move the dialysis unit out of sight until the visit was over. The final machine was called Mini-I (to avoid the word monster). It was delivered four months later and the girl and her mother were trained in its use. By November 1964, hemodialysis had been performed in 40 homes without any significant incidents. The optimization work suggested that short, multiple parallel blood paths with a thickness of about 200 micrometers were best, which eventually led to disposable hollow fiber dialyzers. The Kiil dialyzer, the workhorse since 1960, became obsolete.

Designs were then made for Mini-II, and the university advertised the availability of bid documents. Invention disclosures were prepared, but the design was not patented because in 1964 the University of Washington did not have a patent department (it does now!). One important consideration was that patenting the design would have delayed treatment for people who needed it to stay alive. Only four bids were received, and Milton Roy Company of St. Petersburg, Florida, was selected. By the end of 1965, five additional patients were using the commercial device for their kidney dialysis. All the patients did the dialysis during sleeping hours at home. As machine use spread around the country, it was found that some tap water had to be purified (Seattle's water was sufficiently demineralized that this had not been necessary).

In 1977 Dr. Babb published a paper that was recognized in 1996 as the top Landmark Article in 25 years in *Dialysis and Transplantation*. It showed that vitamin B-12 could be used as a surrogate molecule to design dialyzers to remove molecules with high molecular weights in addition to urea and creatinine, the main chemicals of interest. The paper gave clear, concise instructions on the design and optimization of the units.

Les Babb was recognized by membership in the National Academy of Engineering (1972) and Institute of Medicine (1982). He received the Clyde Shields Distinguished Service Award of the Northwest Kidney Foundation (1992) and was named one of the top 100 chemical engineers in the modern era by the American Institute of Chemical Engineers (2008). He was a member of the Washington State Academy of Sciences and a fellow of four technical societies. He held 21 patents and authored or coauthored 170 journal publications. A registered chemical and nuclear engineer, he was a member of 15 professional and scholarly societies, served on countless boards nationwide, and consulted with numerous companies, largely in nuclear engineering and for the Public Health Service and medical device firms. He supervised 106 graduate students in nuclear engineering and chemical engineering, 11 of whom became university faculty members. He retired in 1991 as professor emeritus of chemical engineering and nuclear engineering. His most lasting legacy, though, is the 500,000 patients around the world who undergo dialysis using commercial versions of the Mini-I prototype.

References

Babb AL. 1995. Design and construction of a portable, single patient, dialysate proportioning machine at the University of Washington 1964–65. Journal of the American Society of Artificial Internal Organs 41(1):1–10.

Babb AL, Strand MJ, Uvelli DA, Scribner BH. 1977. The dialysis index: A practical guide to dialysis treatment. Dialysis and Transplantation 6(9): 9–12, 62.

Blagg C. 2014. A History of Northwest Kidney Centers, Chapter 20: Professor Albert Leslie “Les” Babb and the Development of New Dialysis Technology (pp. 98–100) and Chapter 21: Home Hemodialysis, 1961–1966 (pp. 101–112). Available at http://issuu.com/nwkidney/docs/nkc-history-book-p1.

Shinaberger JH. 1996. Landmark articles. Dialysis and Transplantation 25:622–630.