David Eddy helped shift the basis of medical decision making from expert consensus to modeling results through “virtual” clinical trials.

David Eddy Created The Archimedes Model To Predict And Analyze Care

When David Eddy, fresh out of medical school at the University of Virginia, was training for a career as a cardiovascular surgeon in the early 1970s, he was “shocked” to discover that critical medical decisions about treatments and interventions were being made based on “standard and accepted practice”—that is, what physicians believed worked, or what they saw other physicians doing—rather than on evidence.

“At that time there was no such thing as evidence-based medicine, performance measurement, or even guidelines as we think of them today,” Eddy, who turns 71 this month, explains. The need to examine evidence of effectiveness before recommending a treatment was an unknown concept, and coverage and payment policies were decided based merely on expert opinion, which Eddy saw as a weak basis for clinical decisions.

Eddy sought to change that approach by putting medicine on firmer footing. He switched paths from clinical medicine to applied mathematics, completing his doctorate in engineering at Stanford University. Ever since, he has sought to apply the structure and power of mathematics to medicine and health care. Ultimately, the quest for evidence-based medicine led Eddy to found Archimedes and develop the Archimedes model—a full-scale simulation model of human physiology, diseases, behaviors, interventions, and health care systems. Says health policy expert Lynn Etheredge, “Archimedes is leading the way in developing new predictive models to assure that each patient gets the best preventive care and treatment.”

Archimedes enables clinically realistic “virtual” trials to be run by creating “in silico” physiologies, people, treatments, and care processes that closely represent real ones. Far cheaper and faster than traditional randomized controlled trials, virtual trials can overcome other disadvantages of traditional trials, including lack of generalizability to real-world populations. “Given the advances in computer science and software, the time was right to build much more realistic and powerful models of health care,” Eddy says.

MODEL APPLICATIONS
In this month’s Health Affairs, Eddy and colleagues from Archimedes report on two demonstrations of how modeling can predict the impact of policies and programs on patients. In one article they describe how they used the Archimedes model to determine whether meeting quality and performance targets for the care of patients with diabetes under the Medicare Shared Savings Program would result in substantial cost savings in the early years of that program. (The short answer: It would not, so accountable care organizations in that program would have to look elsewhere for savings.) In another article Eddy and colleagues describe a new way of gauging health care quality called the Global Outcomes Score, developed and tested using Archimedes.

Before he developed Archimedes, Eddy was among the first to use mathematical tools to address complex medical problems with many variables. Eddy began by applying statistical approaches known as Markov models. These assume that patients are always in one of a finite number of discrete health states and that they move from one state to another according to probabilities that depend on the current state of the overall health and health care system.

When Eddy applied Markov models to the question of cancer screening and its relationship to diagnosis and outcomes, his work was instrumental in the formation of the 1980 American Cancer Society guidelines for routine cancer screening. Among other contributions, the guidelines highlighted the potential risks of unnecessary screening—a subject that is still topical today.

As Eddy’s research matured, he became convinced that the available statistical tools, such as Markov models, were too simplistic. They appeared to render complicated questions more tractable, but they did not adequately reflect the complex realities of health and health care. Eddy needed new techniques to better simulate real patients in real time. By the 1990s, thanks to advancements in computing power and software, Eddy and Len Schlessinger, a particle physicist by training, were building Archimedes.

Although no one would argue that any model can replicate reality exactly, Archimedes appears to come close. Validated against dozens of clinical trials and epidemiological studies, the model’s predictions map fairly close to reality.

Archimedes has been used by dozens of organizations, from government agencies to pharmaceutical companies to insurers, Eddy says. But he envisions even broader adoption. “Our mission at Archimedes is to improve the quality and efficiency of health care worldwide,” he says. “That means making the model as widely available, and inexpensive, as possible.”

INTRODUCING ARCHES
To that end, and with funding from the Robert Wood Johnson Foundation, a team led by Eddy developed ARCHEs, an online trial simulator that allows users to run their own health care simulations through the Archimedes model. ARCHEs was completed in early 2012 and will be available to government,
nonprofit, and educational organizations at an “extremely low cost,” Eddy says. In May 2012 the Department of Health and Human Services announced a five-year contract with Archimedes to put the ARCHeS tool in the hands of all of its agencies.

Eddy’s work in modeling and evidence-based medicine has undoubtedly changed the face of medical decision making and sent him down a very different path than he expected when he graduated from medical school. “What really excited me was the intellectual basis of medicine—trying to figure out what works and what doesn’t, and trying to develop methods to ensure that the right patients get the right treatments,” he recalls. “In retrospect, I was never well cut out for clinical practice,” he says, “because I was too troubled by the fact that we were having to make decisions with inadequate evidence.” Now, instead of wielding a scalpel to help save his patients, he employs the tools of mathematics in ways that can improve the health and health care of hundreds of millions, if not billions.