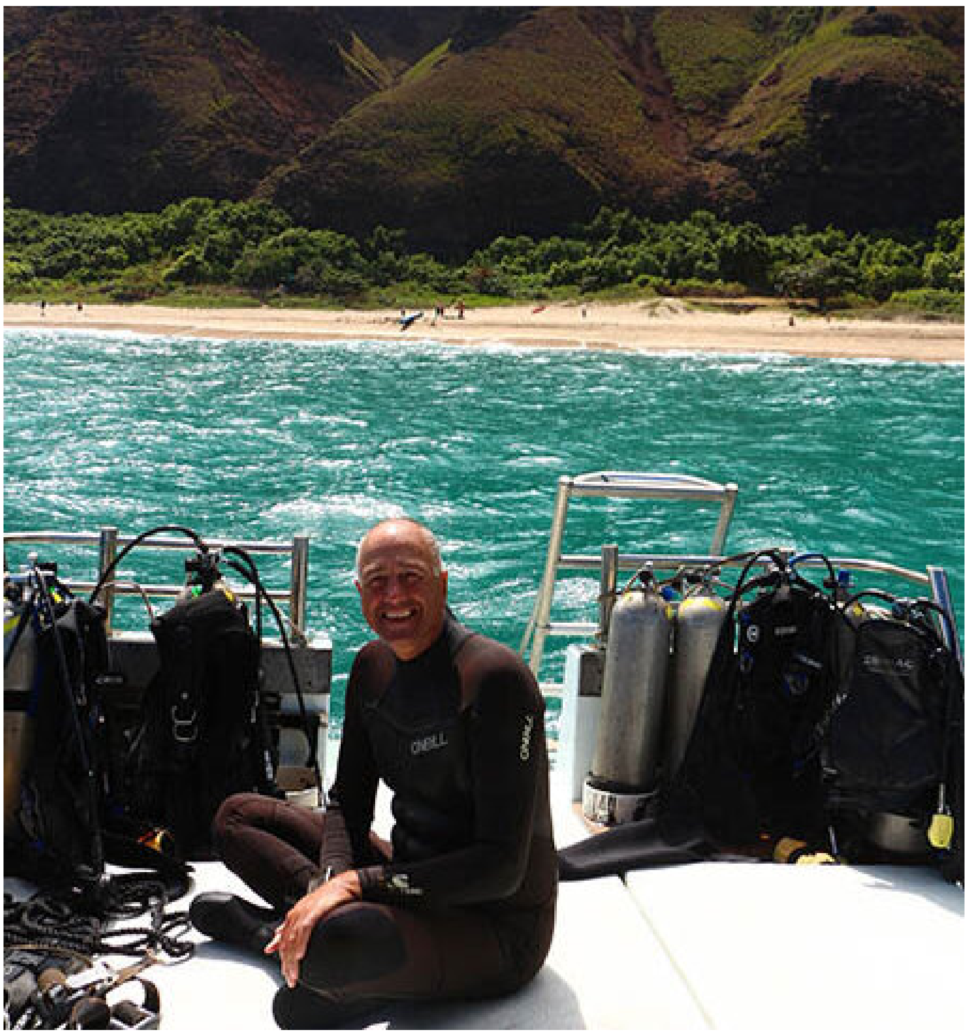
Artificial intelligence tool predicts life expectancy in heart failure patients

November 14 2019



Avi Yagil, PhD, Distinguished Professor of Physics at University of California San Diego, back to his hobbies after a heart transplant. Credit: Avi Yagil

When Avi Yagil, Ph.D., Distinguished Professor of Physics at University of California San Diego flew home from Europe in 2012, he thought he had caught a cold from his travels. When a "collection of pills" did not improve his symptoms, his wife encouraged him to see a doctor.

Further tests revealed something far more life-threatening to Yagil than the common cold. "A chest X-Ray showed my lungs were flooded with fluid, and a subsequent echocardiogram found I had damage to my heart."

Yagil was diagnosed with heart failure. "UC San Diego Health cardiologists tried to manage my condition with medication, but all systems were failing as my heart struggled to keep me alive."

In June 2016, Yagil received a heart transplant. "I consider June 17 my second birthday."

While Yagil recovered from surgery, he began thinking about how he could improve the process for patients like him.

"In my day job, I use machine learning to understand a vast amount of information and measurements of particles and how they interact," he said. "The human body is even more complex, but the medical profession isn't utilizing the technologies that are needed to capture the multi-dimensional correlations between the measurements, such as lab tests and vital signs, and the outcomes. We hypothesized that such methodology and techniques could contribute to improving the prognosis and treatment of heart patients with heart failure."

So Yagil teamed up with his doctors, Eric Adler, MD, cardiologist and director of cardiac transplant and mechanical circulatory support and Barry Greenberg, MD, Distinguished Professor of Medicine at UC San Diego School of Medicine and director of the advanced heart failure treatment program, both at the Cardiovascular Institute at UC San Diego Health.

"We wanted to develop a tool that predicted life expectancy in heart failure patients," Adler said. "There are apps where algorithms are finding out all kinds of things, like products you want to purchase. We needed a similar tool to make medical decisions. Predicting mortality is important in patients with heart failure. Current strategies for predicting risk, however, are only modestly successful and can be subjective."

Alder, Yagil and Greenberg, as well as a diverse team of cardiologists and physicists, developed a machine learning algorithm based on de-identified electronic health records data of 5,822 hospitalized or ambulatory patients with heart failure at UC San Diego Health.

From this model, a risk score was derived that determined low- and high-risk of death by identifying eight readily available variables collected for the majority of patients with heart failure:

1. Diastolic blood pressure
2. Creatinine, a chemical waste product of creatine, an amino acid, excreted in urine
3. Blood urea nitrogen, a waste product produced as a result of digestion of protein; an indicator of kidney function
4. Hemoglobin, a protein responsible for transporting oxygen in blood
5. White blood cell count
6. Platelets, a type of blood cell that helps form clots to stop bleeding
7. Albumin, a liver-produced protein that helps keep fluid in the bloodstream and not leak into other tissues
8. Red blood cell distribution

Yagil said the newly developed model was able to accurately predict life expectancy 88 percent of the time and performed substantially better than other popular published models. The results are published online in the November 12, 2019 edition of *European Journal of Heart Failure*.

"This tool gives us insight, for example, on the probability that a given patient will die from heart failure in the next three months or a year," said Adler. "This is incredibly valuable. It allows us to make informed decisions based on a proven methodology and not have to look into a crystal ball."

The tool was additionally tested using de-identified patient data from the University of California San Francisco and a data base derived from 11 European medical centers. "It was successful in those cohorts as well," said Yagil. "Being able to repurpose our findings in independent populations is of utmost importance, thus validating our methodology and its results."

"The development of the risk score marks an important step forward for us," said Greenberg. "Not only did we demonstrate that we could accurately predict outcomes in heart failure patients, we were able to generate the score from the patient electronic medical record data base at UC San Diego Health. We now know how to utilize this data base to address other questions that are of vital importance to our patients."

All three of the investigators said the partnership between physicists and cardiologists was critical to developing a reliable tool and extensive knowledge and experiences from both sides proved synergetic.

"It's been a wonderful collaboration with two groups that don't usually join forces," said Adler. "Our findings need further validation, but we are thrilled to have these results to build upon. Avi has a first-hand perspective as a patient and a strong motivation to help improve existing medical strategies and approaches. Working with him has been a highlight of my career."

"We taught Avi how to think as a cardiologist and he taught us how to think as a physicist would," said Greenberg. "The insights learned have greatly influenced my perspective on how to utilize big data to accomplish important clinical research goals."

"I am back to playing sports and enjoying life with my family after my heart transplant," said Yagil. "I am incredibly grateful to everyone at UC San Diego Health who saved my life and honored that my personal experience has led to a partnership and development that may help others."

More information: Eric D. Adler et al, Improving risk prediction in heart failure using machine learning, *European Journal of Heart Failure* (2019). DOI: 10.1002/ejhf.1628

Provided by University of California - San Diego