Software Program Gets To The Heart Of Electrocardiogram (ECG) Results

University of Glasgow

Back in the late 1960s, a University of Glasgow professor sat down with a piece of blank paper and a pencil to begin developing software for electrocardiogram (ECG) analysis.

"No equipment whatsoever," chuckles Peter Macfarlane, who still works at the Glasgow Royal Infirmary. His title is professor of electrocardiology, which is the study of the electrical activity in the heart.

Electrocardiography — the branch of electrocardiology dealing with displaying and interpreting electrical signals the heart generates — is a starting point for detecting many cardiac problems. Some of these cardiac problems include irregular heartbeats, heart attack and some congenital heart conditions. The electrocardiogram is used routinely in physical examinations and for monitoring a patient's condition during and after surgery, as well as in the intensive care setting.

It is the basic measurement used in exercise tolerance tests and is also used to evaluate symptoms such as chest pain, shortness of breath and palpitations.

Forty years ago, Macfarlane says, there were only two places in North America that were developing methods for ECG analysis.

"A cardiology professor in Glasgow at that time thought it would be interesting to do something along the same lines in Scotland," he says. "That's how it all started."

Eventually, his team got a small lab computer so he and his colleagues didn't have to deal with the university's cumbersome KDF9 computer, which Macfarlane jokingly says was so big it occupied about half a soccer field.

"As things moved on from there, we obtained some support from the Scottish government in the 1970s," he says. "Eventually, by the late 70s, they gave us a large grant and said we'd have to go out and find commercial partners. And that's what we did around 1981." The university hooked up with a prominent German electronics manufacturer, which signed an agreement with the university to use Macfarlane's algorithm in the ECG equipment it was developing in its Swedish plant. Since then, through a series of acquisitions, a license to use the technology has been granted several times to different medical equipment manufacturers. The Glasgow software is now incorporated into ECG machines made by Burdick, a division of Seattle-based Cardiac Science.

The Glasgow ECG Interpretation Algorithm has been continuously improved since its initial development, allowing it to stay abreast of the latest advancements in electrocardiographic research, company officials say.

"The faculty of medicine in Glasgow is at the forefront of new technology and we are continually working with our partners to improve health care throughout the world," Macfarlane says.

> *While other products use only age and gender to a limited extent, Macfarlane says the University of Glasgow ECG Interpretation Algorithm — a set of diagnostic rules sometimes involving complex math built into a software program — uses five clinically significant variables. They are gender, age, race, medication and clinical history.*

This is critical because ECG patterns for patients of various ages from different ethnic backgrounds and with differing medical conditions can vary greatly, he says.

Macfarlane collaborates with Cardiac Science and travels regularly to the Deerfield, Wis., facility where Burdick ECG machines are manufactured. The University of Glasgow receives royalties for each machine sold that includes his algorithm.

Alex Castro, director of international marketing for Cardiac Science (Nasdaq symbol: CSCX), says his company is indebted to Macfarlane for his time, research and entrepreneurial spirit.

"Peter is the renowned authority in electrocardiology and Cardiac Science is thrilled to partner with him," says Castro. "We've woven Peter's algorithm into several generations of Burdick ECG devices and we regularly work with him on new product development."

Helping Different Age Groups

Macfarlane says the algorithm and software have evolved over time. "It started off initially as an adult program," he says. "But by the late 1980s, we got money to look at ECGs in newborn babies and children."

Researchers then developed a pediatric ECG database in Glasgow that eventually had 1,750 healthy youngsters' ECGs, all recorded with the permission of the children's parents. By the early 1990s, they had added to the analysis program

the ability to analyze ECGs from children as well as adults.

"The ECG of a baby is quite, quite different compared to the ECG of an adult," he says. "Children are not small adults. There is a continuing change from birth right through to adolescence. And as individuals get older the electrical activity diminishes a little bit and the size of the wave forms (on the ECG graph) decreases with increasing age. Also, men tend to have higher signals than women. And that has to be built into the program, too."

After the work with babies, they added the capability to compare ECGs over time.

"If you had an ECG from the minute you entered the hospital with chest pain, you could automatically compare it with an ECG on the second day," he says. "It's quite important to be able to compare ECGs recorded on different days, different hours in fact."

Ethnic Considerations

Macfarlane also has worked with researchers in Taiwan to get a database of ECGs from Chinese patients, which allowed him to put ethnic considerations into the program. He says researchers at the University of Glasgow are now recording ECGs from different ethnic groups, and so he hopes to further enhance the software with newer criteria.

Macfarlane says his algorithm offers two kinds of output for physicians to help them interpret the ECG data.

"One is a little bit more verbose in providing some reasons as to why the diagnosis was made," he says. "That one is really for family practitioners. We also have a shorter interpretation that we would expect to be used in the hospital environment by physicians who are more familiar with ECGs."

Macfarlane also says he believes his algorithm places more emphasis on the age and gender of patients than those of other vendors.

"As far as I know, no other manufacturer has access to a database of 1,750 ECGs from healthy children like the one we gathered that allowed us to develop our criteria for newborn babies and children.

"We are always looking for ways to improve interpretations based on experience," he says. "Believe it or not, the definition of a heart attack keeps changing from a clinical point of view as new biomarkers like troponin (a complex of three proteins integral to muscle contraction in cardiac muscle) have become available to indicate damage to the heart muscle."

He says his work has resulted in some new ECG criteria for acute heart attack. These criteria are being adopted by international bodies, such as the European Society of Cardiology as well as the American College of Cardiology and the American Heart Association and have very recently been published in the relevant cardiology journals.

"These criteria will include some of the things we have been shouting about for quite some time, including the differences in ECGs of women and men," he says. "This criteria update is based solely on our efforts here in Glasgow to point out these things to the international community".

"That," he says, "is satisfying." "It's also been very good to have such a good collaboration with Burdick over the years," he adds. "They are certainly a leader in the field."

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