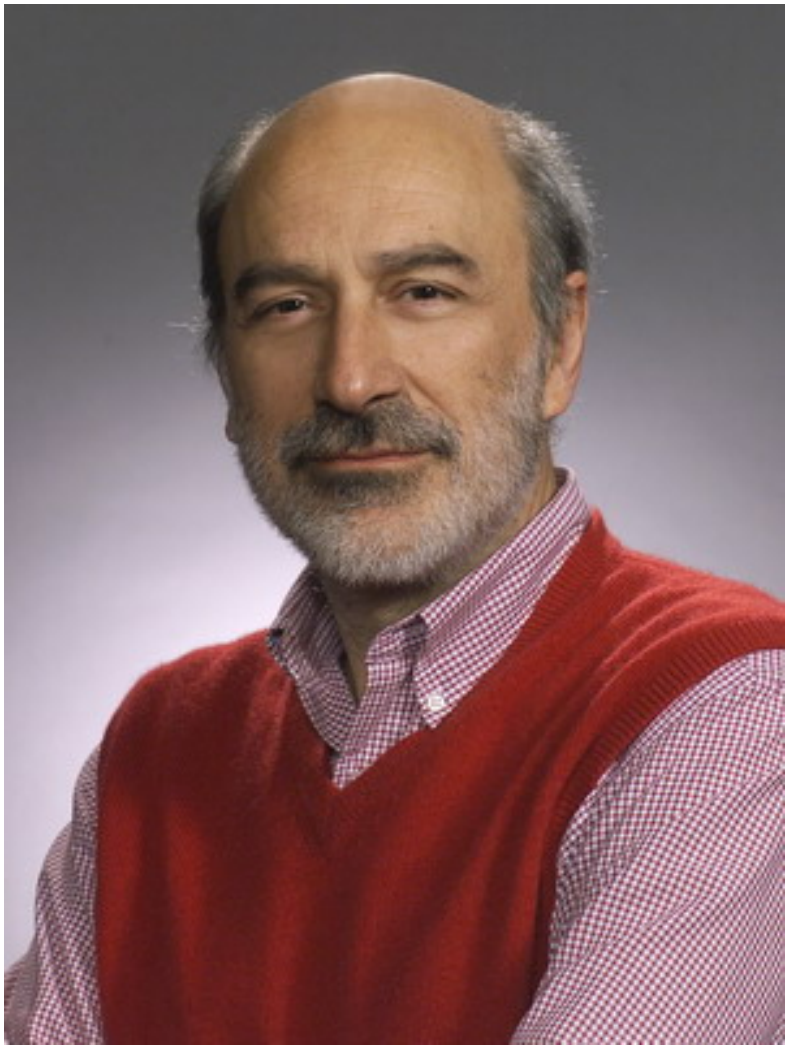
GATOR Engineering News
at the University of Florida

December 20, 2004

New Fetal Heart Monitor Could Give Better Health Picture During Labor, Say UF Researchers



photo/David Blankenship

Related Links
- Jose Principe

Anyone who's tried to tune in a distant radio station knows how multiple signals can overlap and muddle each other. In hopes of giving doctors a better assessment of fetal well-being, University of Florida physicians and a private engineering firm are developing what could be the first commercial monitoring system to noninvasively detect electrical activity in the baby's heart, producing a fetal electrocardiogram, or EKG, said Dr. Tammy Euliano, a UF associate professor of anesthesiology, and obstetrics and gynecology.

When perfected, the system might help reduce the number of Caesarean deliveries, which have increased dramatically since the 1960s, when ultrasound was introduced, she said. It also may detect abnormal fetal heart rhythms, distinguish false labor from early labor, and track the mother's heart rate and the strength of her uterine contractions.

"There have been some preliminary studies by other groups that say fetal EKG is a more

Jose Principe, UF distinguished professor of electrical and computer engineering and director of UF's Computational NeuroEngineering Laboratory

accurate predictor (than ultrasound) of how the baby's doing during labor," said Euliano, who is affiliated with UF's McKnight Brain Institute. "Currently, the only way to get that information is with what's called a scalp electrode. It's actually a little wire that they place into the baby's scalp during labor, and through that they can get the EKG."

Scalp electrode systems are common in U.S. hospitals, but their use is limited to the final stages of labor, when the baby's scalp is accessible through the birth canal, she said. The new system uses sensors placed on the mother's abdomen with an adhesive, so it could be used at any time during labor and even earlier for mothers with health conditions that place their babies at greater risk of complications, such as diabetes or heart disease.

Unlike the belts used for ultrasound monitors, the EKG sensors are unaffected by the mother's movement or her body fat content, Euliano said. But both systems have one thing in common: the problem of separating all the incoming signals, which include the baby's heartbeat, the mother's heartbeat, uterine contractions, muscle movement and noise.

The problem hasn't been resolved sufficiently for noninvasive EKG monitors to reach the market, said Neil Euliano, a UF courtesy assistant professor of anesthesiology and president of Convergent Engineering, a Gainesville-based biomedical engineering company involved in the project. He is Tammy Euliano's husband.

In the next few years, the UF/Convergent research team plans to refine the system by monitoring hundreds of patients in conjunction with ultrasound monitors, Tammy Euliano said. Not only will researchers compare results from the two systems, they also will examine pregnancy outcomes and look for features in the fetal EKG readings that could indicate fetal well-being, labor characteristics and abnormal fetal heart rhythms.

The main component of the system is a complex mathematical program called MERMAID that separates data from multiple sources faster and more efficiently than its competition, Neil Euliano said. MERMAID stands for Minimum Renyi's Mutual Information, a shorthand description of the program's data-sorting strategy.

Developed by Jose Principe, a UF distinguished professor of electrical and computer engineering and director of UF's Computational NeuroEngineering Laboratory, and his students, MERMAID was 60 percent more reliable in isolating fetal and maternal heart rate than one popular data-sorting program and 30 percent better than another. These results were from a joint UF/Convergent study using all three programs to sort heart-rate data from about 50 patients monitored during labor with the EKG system and standard ultrasound.

The system includes an amplifier that magnifies fetal EKG signals without affecting the much stronger

maternal signals, and computer programs used after MERMAID completes its work, to calculate and label the fetal and maternal heartbeats and assign a “trust factor” to indicate the information’s reliability, he said.

Ultimately, fetal heart rate may be one of the less important pieces of data the EKG system delivers, said maternal-fetal medicine physician Dr. Rodney Edwards, a UF assistant professor of ob/gyn who is a member of the research team. Although continuous fetal heart rate monitoring is a standard practice for birth care, it’s used primarily because it’s the only data doctors can obtain, Edwards said.

“The goal of our project is to find something in the electrocardiogram that maybe will help us improve outcomes,” he said, referring to the possibility that features in the pattern of electrical activity would correlate strongly to fetal well-being and thus give doctors better information than ultrasound provides. Study findings from the past four decades indicate ultrasound, although used since the 1960s, has not improved outcomes and may have contributed to dramatic increases in Caesarean section procedures, he said. “When this system was adopted, the Caesarean delivery rate in the United States was about 5 percent,” he said. “Largely due to increases in deliveries due to abnormal heart rate patterns, the rate now is in excess of 25 percent.”

If further testing and refinement shows the new system is reliable and applicable to clinical situations, a commercial version could be marketed in three to four years, Neil Euliano said. The research team has applied for a patent and is in early discussions with a major medical device manufacturer. Funding for the project was provided by National Science Foundation small-business research grants totaling $600,000.

Thanks to evolving computer and software technology, noninvasive EKG monitors suitable for clinical use are likely to become a reality in years to come, said Dr. George Saade, a professor of obstetrics and gynecology at the University of Texas Medical Branch in Galveston.

“It's almost like an explosion, these advances,” said Saade, who is researching a related noninvasive method called uterine electromyography to monitor uterine contractions. “The next step would be to prove that having this result is going to make a difference as far as improving the outcome for the baby, or a difference as far as decreasing the C-section rate or changing the way we manage labor,” he said. “How long it will take to prove all that is very hard to tell.”

For more information, contact: Tom Nordlie, (352) 392-2755, tnordlie@vpha.health.ufl.edu

Contact: Ron Franklin, Engineering Publications Services
Tel: (352) 392-0984
Email: rfran@eng.ufl.edu