



Wireless heart monitoring cuts healthcare costs

An inexpensive, ANT-powered ECG patch promises to take the pressure off hospital intensive care units by predicting relapses. *ULP Wireless Quarter* reports

Intensive care doesn't come cheap. Specially trained medical staff, complex monitoring equipment, exotic drugs, and round-the-clock care stretch hospital budgets.

But even the hardest-hearted administrator isn't about to slash intensive care funding. These specialized facilities deal with critically ill people, and managers aren't keen to be seen putting a price on a human life.

Nonetheless, there is an ethical way to reduce the expense of such a department by ensuring that patients, who've recovered sufficiently to move to a general ward, don't relapse and return. And as if that wasn't incentive enough, the increasing vigilance of insurance companies, looking for the slightest excuse to offload their financial responsibilities, should close the deal.

"Around a third of patients currently relapse and have to be returned to intensive care," notes Keith Errey, CEO of Isansys Lifecare, a company that develops and implements continuous physiological patient information platforms. "The cost of putting a patient back into critical care is an order of magnitude more than keeping them on a general ward."

The heart of the matter

Intensive care is characterized by rigorous patient supervision. Sick people are constantly monitored by an array of expensive equipment displaying and recording vital signs such as pulse, blood pressure, respiration rate, and blood oxygen level. Medical staff can rapidly intervene if these vital signs change for the worse.

But when a patient stabilizes



Intensive care is an expensive business

"THE BATTERY LIFE USING ANT TECHNOLOGY IS TERRIFIC; WE'VE BEEN ABLE TO TRANSMIT USEFUL ECG DATA CONTINUOUSLY FOR 150 HOURS FROM A SINGLE CR2032 COIN CELL BATTERY"

and moves to a general ward, there's a step change in the observation routine. That's acceptable for an improving person, but it's a problem for one that's about to relapse.

"On the general ward patients are monitored perhaps once every two hours or even every four hours," says Errey. "Unfortunately, a lot of changes can occur between readings."

What's needed is a low cost way of duplicating the continuous monitoring typical of the intensive care environment on the general ward, but without the cost. That way, patients in danger of relapse can be identified early and treated while still not sick enough to merit a return to critical care. Today, no

such solution exists, but Errey says that's about to change.

"At Isansys our business model is to offer a continuous physiological monitoring service for general care patients comprising monitoring devices for vital signs such as pulse, blood pressure, and blood oxygen levels," he explains.

Isansys' solution starts with a semi-disposable wireless cardiac monitor supporting low-cost continuous ECG heart monitoring. Called the LifeTouch HRV011, the monitor is now available for deployment via structured proof-of-concept studies.

To the experienced medical practitioner, an ECG trace of a series of heartbeats reveals

much about the health of a patient (see figure 1). The trace tracks the electrical activity of the heart which directly correlates to the muscle activity during the beat and therefore how the heart is performing.

For example, a larger than normal amplitude of the 'QRS' complex indicates cardiac hypertrophy (increased heart muscle mass), and a shortening duration can indicate the onset of arrhythmia (irregular heart rhythms that can lead to a cardiac arrest).

Another of the key clinical parameters is known as heart rate variability which is measured by looking at how the relative positions of the "R" peaks vary over time.

“The normal state exhibits a large change in variability, whereas the pathological or sick state, exhibits minimal variability,” explains Errey. “There have been many algorithms developed to predict a series of things ranging from stress all the way through to imminent cardiac arrest. It is an interesting parameter to measure with accuracy, and that’s what we’ve done [with Lifetouch].”

Data reduction

But the clever part of Lifetouch is not so much in what it measures, as what it then does with the collected raw data.

Isansys needed the monitor (or ‘patch’) to be unobtrusive and inexpensive, yet able to connect to the hospital’s intranet. Wireless technology looks after the connectivity, eliminating inconvenient cables (which can also generate unwanted artifacts in the ECG signal).

To keep it unobtrusive, the device is compact and light. And because the patch needs to be cheap, it uses proven, readily available electronics.

The company chose Nordic’s nRF24AP2 single-chip-connectivity 2.4GHz ultra low power (ULP) transceiver running Cochrane, Canada-based ANT’s RF protocol software (with Isansys’ own application layer) for the wireless functionality. Processing power is provided by Energy Micro’s Gecko microcontroller. A CR2032 3V coin cell powers the electronics.

Lifetouch samples at 1000Hz with 12-bit resolution, generating 12 kilobits of data per second. But instead of continuously transmitting this across the wireless link, which would place a heavy toll on the battery, the device uses an intelligent data reduction algorithm whereby the key clinical parameters are extracted from the relatively large volume of raw data. The algorithm is extremely efficient and can reduce the 12kbps down to just a few hundred bits per second of essential data.

“We didn’t need a radio with

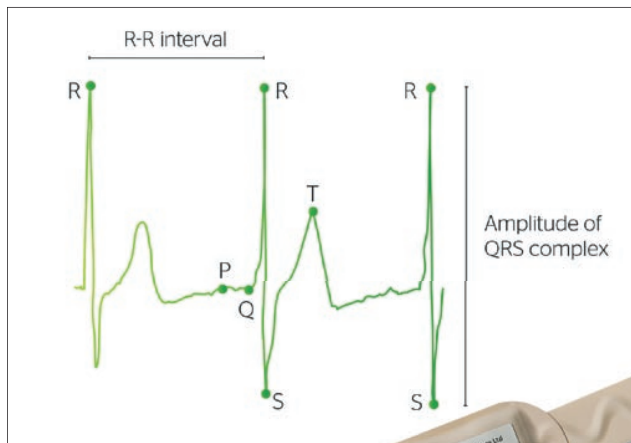
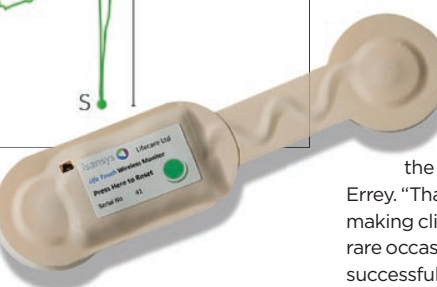


Figure 1: Typical ECG waveform (normal sinus rhythm) showing standard features, including those measured by the LifeTouch HRV011

large bandwidth, but we did need one that was ultra efficient and consequently yielded long battery life,” says Errey. “That’s one of the reasons why we chose Nordic’s ANT chip.”

According to Errey, *Bluetooth* [wireless technology] was not a good choice because of power consumption and the fact that if the signal is lost, it takes a long time to re-establish the link. He adds that ZigBee was not suitable because it’s primarily designed for control applications rather than healthcare. And low power Wi-Fi was far too demanding on the battery.

“The battery life using ANT technology is terrific,” Errey enthuses. “We’ve been able



to transmit useful ECG data continuously for 150 hours from a single CR2032 coin cell battery. In a normal operational mode [transmitting four times a second with the microcontroller continually analyzing data] the battery life is specified for 100 hours of continuous operation.”

The ECG patch transmits to a ‘gateway’ device that acts as a hub – which will eventually take the data from all the patient’s wireless monitoring devices – and performs some more processing on the information before sending it via TCP/IP to the hospital intranet.

Isansys’ Lifetouch utilizes ANT’s proven software protocol, as used in millions of wireless

applications across the world. According to Errey, that ANT ‘ecosystem’ increased the company’s confidence in the ability of the technology.

On top of the base ANT protocol, Isansys has developed its own customized application layer that meets the stringent requirements demanded in medical implementations.

“It’s important that we can maintain the required regulatory status of the protocol for the lifetime of the product,” explains

Errey. “That includes not making clinical decisions on the rare occasions that data isn’t successfully transmitted across the wireless link. The software tells us when that happens.”

The next ‘big thing’

“I think technology like this will be mandated for every hospital patient in a few years time because it serves as a quantitative measure of health-care delivery,” says Errey. “The ability to provide this measure will become universal on the clinical care side, because, among other things, it will ensure that the hospital can prove to interested parties that it has met its duty-of-care obligations.”

Errey says that from as early as next year, this will become even more important as many major medical insurers in the U.S. threaten to treat re-admissions to intensive care as a failure on the part of the hospital and will then refuse to pay for care.

“I think that makes Lifetouch very timely,” he says. “And it means wireless health monitoring is going to be vast – I really think this is the ‘next big thing.’”



LifeTouch HRV011 is now available for deployment via structured proof-of-concept studies

Further info:

For more information on Isansys Lifecare go to www.isansys.com/en/lifetouch_monitor. For more on ANT go to www.thisisant.com, for more on Nordic’s nRF24AP2 go to tinyurl.com/3rbjbyz