Digital Technologies Jump Start Telemedicine

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THE technologists, research doctors, computer programmers, electrical engineers, and biomedical engineers who design and create new medical diagnostic equipment and medical treatments are now working on medical systems that use the computing power of personal computers and cell phones. For disease diagnosis, they are finding ways to shrink expensive medical equipment down to cell phone size. Their goal is to perform diagnosis and treatment without requiring a patient to spend a great deal of time in doctors' offices or hospital beds.

For medical treatment, they are creating new wearable or implantable sensors that gather medical data from patients. A cell phone app performs the data analysis of the raw biometric data that was gathered by these sensors. When processing is done, the cell phone "phones home" to report its findings to whomever it was programmed to call.

For lifestyle changes, similar teams of experts are designing biometric sensors that collect data through skin contact on an arm, leg, chest, or head. The computer program that is part of the system turns this data into biofeedback, which the person uses to reduce tension, track physical activity, improve cardio function, tone muscles, train for the Olympics, and/or lose weight.

The cell phone in Photo 1, the H'andy Sana 210, requires its owner to touch certain edge points on the phone. This allows the cell phone to perform an electrocardiogram (EKG). The phone spends the next 30 seconds checking the electrical activity of the person's heart. The test results are graphically shown on its screen in exactly the same format as a conventional EKG. The phone then sends the results to the attending physician for proper medical interpretation.

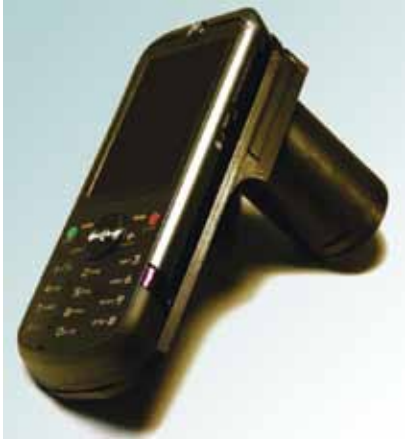
MMB Medical Marketing Berlin

Photo 1—This cell phone performs an on-the-spot EKG. A new model that can also register body temperature and blood pressure is expected to receive FDA approval this year.

The H'andy Sana 210 will allow doctors to frequently monitor patients who have heart-related medical conditions without requiring them to constantly revisit a medical office or hospital. The information gathered and sent by the cell phone can determine if a chest pain is a heart attack, if the symptom that the person is experiencing requires immediate medical attention, if prescribed medicines need to be adjusted, and even if a previously installed pacemaker is working properly.

If you use *Technology Today* as a jump-off point for research, you will be amazed by how many new technologies can be classified as cell phone telemedicine initiatives. The cell phone microscope is another example of a new telemedicine tool. It is a fascinating repurposing of the new high-pixel-count digital cameras now found on most cell phones. Aydogan Ozcan, an assistant professor in the Electrical Engineer Department at the University of California Los Angeles, recently developed this diagnostic tool. (See Photo 2.)

Ozcan's cell phone microscope should soon be a boon to medical diagnosis and treatment of patients in third-world countries. I called Ozcan on December 15, 2010, to determine the status of his invention. He told



Aydogan Ozcan

Photo 2—The cell phone microscope uses an internal app to analyze the photo it takes of a blood sample.

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me that they "are still lab testing the design and expect field testing to begin soon." There is a good chance that by the time you read this column the cell phone microscope will be undergoing field testing in Brazil.

The first field tests will use the cell phone microscope to test for malaria parasites in blood samples. To perform this test, a blood sample is placed between two glass slides. The cell phone microscope has a built-in fixture to properly align the distance between the camera lens and the glass slide. There's no need for a trained technician to prepare the slide or snap the picture. After the picture is taken, the software on the cell phone performs the analysis and determines if the sample contains signs of the malaria parasite.

The BodyMedia Fit was the most interesting lifestyle product that I investigated and tested for this article. The system includes an activity monitor that is worn on an arm. (See Photos 3 and 4.) The sensors in the armband gather sleep and physical activity data wirelessly, using Bluetooth, and transmit the information to your iPhone or Android Smartphone. You can also use a USB cable to download the data directly to a computer.

To get started with the BodyMedia Fit, you download software from the company's website to your computer and an app to your phone. The BodyMedia Fit program is designed to help people lose weight.

The activity monitor doesn't have an on-off switch; it is activated by

Photos 3 and 4: BodyMedia

Photo 3 (above)—The activity monitor on the girl's arm determines whether her workout is moderate or vigorous activity.

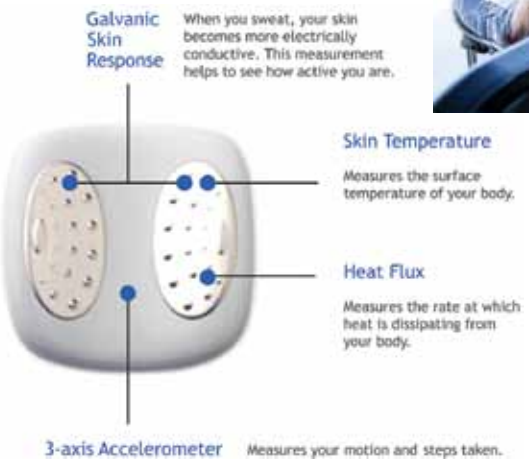

Photo 4 (left)—The monitor has many sensors that gather information through direct contact with the skin.

skin contact. It gathers four different types of data. Its galvanic skin response sensor measures a body's electrical conductivity. Basically, when you sweat, your body becomes a better conductor of electricity so by monitoring your body's electrical conductivity over time the sensor can determine how active you are.

The galvanic skin sensor pools its information with the monitor's skin temperature sensor, heat flux sensor, and three-axis accelerometer. By analyzing body temperature changes, the speed at which the body is dissipating heat, body perspiration, and body movement (walking, running, bending, twisting, etc), the sensors can tell how many calories you are burning. When the calorie burn per minute is greater than three times the resting calorie burn, the activity per minute will be credited as moderate activity. When the calorie burn is six times greater per minute, the time is credited as vigorous activity.

It is the three-axis accelerometer that determines whether you are moving or resting. The sleep algorithm reads into the fact that you are lying down with very little physical movement. A person being at rest, coupled with the other sensor readings, is credited as sleep. The activity monitor sensors collect data at a rate of up to 32 samples per second. (Explaining how the sensors gather their information in simple English could not have been accomplished without the assistance of Michael Oncea, a BodyMedia supervisor.)

For this system to work, you enter your profile into the BodyMedia program and log daily meals and snacks. Your meals are turned into consumed calories and your personal data (height, weight, sex, and age) are converted into your personal activity program. The dashboard on your computer or cell phone shows how much you need to do to burn more calories than you consumed.

The question that must be answered when it comes to all lifestyle systems is: Does it accomplish what it is supposed to do? The TV show *The Biggest Loser* has made the BodyBugg famous as a tool for monitoring physical activity and eventual weight loss. The BodyBugg and the BodyMedia Fit are both made by BodyMedia and both have the same functionality. The question becomes a personal one: Will this system, without the nutritionists and physical trainers of a TV show, provide the necessary motivational feedback to keep you on track to lose weight?

My wife, Shelley, volunteered to test the BodyMedia Fit. She has found wearing it, logging her meals and snacks, and using her cell phone to monitor her balance between calories consumed and calories burned to be very motivational. Since testing began, she has already lost a few pounds.

Recalling the Facts

1. What type of new technologies does this article refer to when it uses the phrase "cell phone telemedicine initiatives"?

2. What new advances in communication technology have made it possible for companies to bring to market so many new, tiny medical and lifestyle systems?

More than Fun Answers

Good Shot
A Both arrows are subject to the pull of gravity and to the laws of falling bodies. The arrow from archer I appears unaffected by gravity, it travels in a nearly straight path. To travel in a nearly straight path, the arrow from archer I had to have a higher speed than the arrow from archer II. In order to give the arrow a higher speed, archer I must have a more powerful bow.

You Light Up My Life
B Number II is a series circuit. In a series circuit the current flows from one bulb to the other before returning to the battery. If one bulb is removed, there will be no complete path or circuit.

A The electrical power to each bulb in system I, the parallel circuit, is V2/R where R is the resistance of the bulb. In system II, the voltage across each bulb is half of the battery charge, or 6 V, because there are two bulbs on the same circuit. The higher voltage will push more current through the bulbs, and they will burn brighter.

Can You Hear Me Now?
B Speaker II is shaped so that the distance from the base to the face is greater. The face is smaller. The sound waves are more tightly focused. This tighter focus concentrates the sound energy in a smaller area and it will project the sound farther.

Weighty Decision
A In order to balance, the product of each weight times its distance from the pivot must be equal. To tip the scale to the left, the product of the 18-lb weight and its distance from the pivot must be less than the 12-lb weight and its distance from the pivot. This will be true only if the 18-lb weight is hung at point I.

