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Biosensors and Your Health

What's Your Body Trying to Tell You?

By Alice Oglethorpe

Your body alerts you to many aspects of your health. Your stomach growling tells you when to eat. A powerful yawn lets you know you're tired. Your body gives off many other valuable signals, but requires technology to detect them. Scientists are looking for new ways to track and use your body's signals to improve your health and manage disease.

Physical activity trackers and step counters are now helping people develop and maintain healthy habits. These devices have also opened doors for people to participate in health research. Now, researchers are designing more advanced devices called biosensors that measure biological, chemical, and physical signs of health.

"The variety of biosensors used by researchers, clinicians, and people from every walk of life is growing," says Dr. Šeila Selimović, a biosensors expert at NIH. "Some speed up test results so treatments can be started promptly. Others provide the benefits of continuous monitoring of health conditions. [Biosensors] function in fascinating ways. [They use] chemical attraction, electrical currents, light-detection systems, and compact wireless-sensing technologies."

The mercury thermometer is one of the earliest biosensor technologies used in medicine. In modern thermometers, mercury has been replaced by safer temperature-sensitive probes. But the goal is still the same: to detect changes in your body temperature.

Another common biosensor used at home is the pregnancy test. Home pregnancy tests use color-changing strips to detect pregnancy hormones in urine. Pregnancy tests are still done in doctor's offices. But the home test has become a reliable alternative since it was first introduced more than 40 years ago.

The rapid strep test is another commonly used biosensor. If you have a sore throat, your doctor may want to use one to test for bacteria called streptococci. The rapid strep test can provide results from a swab of the back of your throat in a few minutes—with 95% accuracy. Your doctor may still send a throat swab to a lab to confirm a positive test result. But they can use the rapid test results to start treatment immediately.

In parts of the world where public health care isn't readily available, researchers hope to introduce rapid tests for people living in remote regions to test for infections like influenza, HIV, and hepatitis C. New biosensor technologies can now be combined with smart phone cameras and wireless signaling. These advances make health tests more portable and affordable than lab-based equipment.

Biosensors can also be used to continuously monitor a health condition. Blood-oxygen monitors are now found throughout hospitals and in patients' homes. These devices detect changes in the level of oxygen in the bloodstream. A rapid drop in oxygen can cause brain injury and requires quick medical attention. Blood oxygen monitors are ideal for people with lung and heart conditions, those undergoing anesthesia, or those being treated in intensive, neonatal, or emergency care. Other biosensors can be used to continuously monitor your blood sugar levels (for managing diabetes), blood pressure, or heart rate.

Flexible sensors are making even more types of monitoring possible. A team of engineers, led by Dr. Patrick Mercier and Dr. Joseph Wang at the University of California San Diego, is developing a flexible sensor that measures blood alcohol levels. It looks like a temporary tattoo. The sensor releases a sweat-promoting chemical into the skin and detects alcohol in the sweat. The sensor then sends the information wirelessly to a laptop or mobile device. Similar devices are being developed by other groups to monitor cystic fibrosis and other diseases and conditions.

At the University of Minnesota, a group of researchers led by Dr. Michael McAlpine has developed inks for 3-D printing sensors that are flexible, stretchable, and sensitive. These sensors can be used to detect human movements, such as

Content provided by NIH News in Health,

flexing a finger. They can be printed directly onto skin and used to detect body signals, like a pulse. They can also detect chemicals in the environment and be used to warn of hazards.

NIH also supports research to use sensors to gather data about environmental and other factors involved in childhood asthma. These sensor systems monitor what children are exposed to and their body's reactions. For example, Dr. Zhenyu Li, a biomedical engineer at George Washington University, is developing a sensor that can be worn on a child's wrist to detect formaldehyde, an air pollutant that can trigger asthma.

"Researchers don't have tools at the moment that can monitor environmental triggers, physiological responses, and behavior without interrupting normal activities," Li says. There are many different asthma triggers, he explains. He expects to have a wearable sensor prototype that he and his clinical partners can begin testing with patients. He's also working on a device that can be placed in a child's home to detect multiple air pollutants, like those found in tobacco smoke and some manufactured wood products, such as flooring and furniture.

Biosensors can be placed inside your body as well. Dr. Natalie Wisniewski, a biomedical engineer at a medical device company in San Francisco called Profusa, is developing miniature sensors that can be injected under the skin. These sensors automatically track chemicals in your body without drawing blood. They continuously scan multiple factors at once. Normally, you need to stay in a hospital to have your body chemistry continuously monitored. With this technology, information about the chemicals in your body could be accessed around the clock, from anywhere.

Once placed under the skin, such biosensors can last for months to years. They can monitor various body functions through chemical changes. All this information can be collected on a cell phone app and shared with your physician, a caretaker, or anyone else you choose.

"Health sensors have the potential to dramatically improve the way we practice medicine and shift the focus away from reactive treatments to preventive maintenance," Wisniewski explains.

Biosensors are quickly becoming part of our normal health care routines. New sensor technologies are opening avenues to better health. Researchers are working to develop the biosensors of tomorrow. These could provide access to better health in ways we can't yet imagine.

The Changing Nature of Retirement

Article By: Grace Lattyak, Associate Partner, Aon Hewitt
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Today's grandparents and great-grandparents are generally comfortable in their retirement. They worked hard for many years and were rewarded for it; they have employer-provided pensions and retiree healthcare plans. However, with each subsequent generation, the scale has started to tip away from rich employer-provided retirement benefits.

According to data from Aon Hewitt, 91 percent of plan sponsors provided a defined-benefit pension plan in 1985, 73 percent provided one in 2000, and by 2014, only 20 percent of plan sponsors still had a DB plan. Likewise, employer- provided retiree healthcare plans have declined in recent decades. In 1985, Aon Hewitt's data showed 93 percent of employers had employer- subsidized post-65 health coverage (after Medicare eligibility), 62 percent had it in 2000, and by 2014, only 14 percent of employers still provided coverage.

In addition to less abundant retirement resources, the amount of income needed in retirement is increasing. Since the 1980s, life expectancy has increased by three years and is expected to continue to rise. And, as life expectancies have increased, so, too, have healthcare costs. Since 2000, retiree-healthcare costs have been increasing by an average of 6 percent per year, according to the Centers for Medicare & Medicaid Services.

These colliding factors mean U.S. workers need to rethink the amount of resources they'll need to retire comfortably. The 70 percent to 80 percent replacement ratio "rule of thumb" recommended by the President's Commission on Pension Policy in the early 1980s has become outdated.

The average worker, who contributes to his or her defined contribution plan, will need 11 times his or her final pay (beyond Social Security) to achieve an adequate age-65 retirement, according to estimates from Aon Hewitt. However, since retirement goals and needs are so unique to each individual, that projection should be considered a guide.

With longer life expectancies, projected needs are higher for women than for men (11.5 times pay compared to 10.6 for men). Similarly, younger employees will need to save more because they will likely live longer and will also likely have higher healthcare costs in retirement. For example, employees in their 20s need an average of 12.1 times their final pay while employees in their 50s are projected to only need 8.1 times their pay.

Addressing the Changing Retirement Landscape

As the generations move to and through retirement, these results paint an increasingly somber picture. Key questions emerge, such as:

"At what age will workers be able to retire with adequate retirement resources?" and "How can workers tell if they are on track?"

With a later retirement age, retirement income grows, and the amount needed at retirement decreases. Aon Hewitt projects age 68 will be the median age at which employees with a full career at their current employer and who are contributing to their defined- contribution plan are expected to be financially ready to retire.

With careful planning, today's younger workers could be financially ready to retire at age 65. If 25-year- olds save 17 percent of their annual salary (including both employer and employee contributions), they should be able to accumulate adequate retirement income by age 65.

However, life rarely goes as planned, and it may be more feasible to target milestones along the way. For example, for that 25-year-old, The Real Deal suggests targeting 2.0 times pay at age 35, 4.3 times pay at age 45, 7.3 times pay at age 55, and 9.0 times pay at age 60. This means a 45-year-old making $50,000 needs to have $215,000 in his or her DC account to be on track. Hitting those targets may help employees achieve their retirement income goals.

Employers can help their employees become more successful on the path to adequate retirement income. Automatic features in DC plans can significantly improve results. More than 70 percent of The Real Deal's full-career contributors who are automatically escalating their contributions are projected to have adequate or near-adequate resources at age 65.

Lifetime-income solutions within DC plans will also become more important to retirees. Previously, DB plans provided natural pooling of longevity risk; DC plans require the retiree to manage the risk of living too long. Managing this risk is expensive to do, particularly with the expectation of longer lifetimes.

With the changing retirement landscape, employees need to accept greater responsibility to finance their retirement income and retiree-healthcare benefits. And employers must recognize and react to the changing needs for retirement planning resources and incentives in their workforce.

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