

ARTICLES MEDICAL DEVICES | February 13, 2008

Pocket Protector

A wearable sensor system could help shed light on what really triggers asthma attacks.

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Asthma's toll is painfully clear: some 22.2 million Americans have the respiratory disease, making it one of the most common chronic illnesses. When attacks occur, a person's airways constrict, leading to chest tightness or breathlessness, which in turn can lead to missed days of school or work, hospitalization, or in severe flare-ups, even death. The federal government estimates that asthma-related healthcare costs the nation more than \$16 billion a year.

What's less obvious, however, is what exactly causes these attacks. Over time, people working with their doctors usually figure out their own triggers—smoke, mold, pets can all set off attacks—but it can be more guesswork than science. A need to better pinpoint the causes has led a team of researchers at Georgia Institute of Technology to develop what they believe to be the first wearable sensor system that continuously monitors the air around asthma sufferers. With more information on the triggers, regulators could work to eliminate offending stimuli and physicians could better treat the disease, the scientists say.

"We didn't have an instrument that tests exposure continuously, in real time, and for a broad range of compounds," says Charlene Bayer, a principal research scientist at the Georgia Tech Research Institute. "Currently it's the canary-in-a-coal mine method and it's not a good method."

A Nose in the Air

Designed to fit in a vest's pocket, the sensor system measures airborne exposure to formaldehyde, carbon dioxide, ozone, nitrogen dioxide, temperature, relative humidity, and total volatile organic compounds, which are gases emitted from products such as paints, cleaning supplies, building materials, and office equipment. When an attack occurs, the asthmatic notes the time. After downloading the data from the system onto a computer, Bayer or someone else can determine the levels of compounds that were found in the air at the time of the broncho-spasm. The device, which is only slightly bigger than a cell phone, is outfitted with a pump that pulls air through a mesh filter to also collect particulates—tiny particles linked to a variety of diseases including lung cancer—for analysis.

For Bayer, who has a Ph.D. in organic chemistry from Emory University, the prototype comes after more than 20 years of research in environmental exposures. The quest for more information on asthma triggers has a personal note: Bayer's daughter, now 23, suffered from

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indoor environmental factors that contribute to pediatric asthma. There's a greater prevalence of asthma in children than in adults and the numbers have been rising—8.9 percent of all U.S. children had asthma in 2005, up from just 3.6 percent in 1980.

"If we were able to put these sensor systems on children over a longer period of time, over different seasons, and over different exposures, I'm hopeful we could better understand some of this," says Bayer.

So far, the researchers say the sensor system had positive results when tested for comfort and effectiveness for at least two days in six adult volunteers who didn't have asthma. In fact, the tests in April and May of 2007 helped one of the subjects discover an alarming problem after the volatile organic compounds reading was higher in his home than anywhere else. Turns out, odorless but significant emissions from the individual's car parked in a garage under the house were being released into the living space—a situation that could have been an even bigger problem if the volunteer had been asthmatic.

Now, Bayer and the other researchers are looking to raise additional funding to test the system in children with asthma, among other goals. But they also want to develop a smaller and more sensitive monitor system that could perhaps transmit data readings wirelessly. The current system is battery-powered and weighs less than a pound, but lacks the memory to store much more than a day's worth of data.

Challenges Remain

"The prototype brought to life all the challenges that we would have to overcome to make it less cumbersome and easier to use," says Mark Jones, CEO of Decatur, Georgia-based Keehi Technologies, the maker of the prototype.

Another challenge might be encouraging people to use the device. Asthma expert Asriani Chiu says many of the environmental stimuli for which the system tests are already known to exacerbate asthma and that many patients develop a good sense of what sends them into bouts of coughing, wheezing, and shortness of breath. What's more, there are now effective prophylactic medications taken regularly to reduce airway inflammation and medications that quickly relieve the symptoms when attacks occur, she adds. "I'm not sure that I would use this in my treatment plan at this point," says Chiu, an associate professor of allergy and immunology at the Medical College of Wisconsin in Milwaukee. But she does see potential in the system. "It would be reasonable to measure if patients are not sure what their triggers are or if they have a new [asthma] diagnosis," she says.

As for Bayer, she says that even though the system looks at many known irritants, its promise really lies in being able to establish more causal links. A future generation device, she hopes, could also zero in on what specific element within a stimulus spells trouble for asthmatics. "It would be nice to know, for instance, that it's compound XYZ in perfume and not perfume in general," says Bayer. "That way we could go to manufacturers and regulators and make changes."