Portable cocaine sensor developed

February 27 2006

A real-time sensor for detecting cocaine — made with inexpensive, off-the-shelf electronics — has been developed by a team of researchers at the University of California, Santa Barbara. Two local high school students and a Nobel laureate participated in the discovery. The potential applications of the sensor are far-reaching and include bioterrorism detection and important medical uses.

The high school students made their own sensors and collected data shown in a graph in the scientific article they co-authored describing the work. In the article, published in the Feb. 18 issue of the Journal of the American Chemical Society (JACS), the authors state, "Cocaine serves as an ideal and representative target for testing new analytical techniques due to pressing needs for its rapid detection in law enforcement and clinical settings." The sensor can be housed in supporting electronics that are the size of a small hand-held device.

Co-author and Nobel laureate Alan Heeger said, "We have developed a method of detecting small molecules and proteins in a way that is not specific to cocaine — a whole class of biosensors can be based on this concept. It can be applied to the prevention of bioterrorism. It is beautiful work; the sensor is fully portable." Heeger is a professor of physics and of materials and is affiliated with the Center for Polymers and Organic Solids at UCSB. He won the Nobel prize in chemistry in 2000.

"For me the most exciting thing is that this is a generic, inexpensive way of detecting a range of interesting targets," said Kevin Plaxco, associate

professor of chemistry and biochemistry. "Cocaine is just the tip of the iceberg."

Currently detecting cocaine (and other illegal and legal drugs) in bodily fluids must be done by a laboratory with large and expensive equipment. The process takes from hours to days to get a result.

The potential medical implications of the sensor for detection of prescription drugs may be profound. A drug like cyclosporin, an immunosuppressant that has revolutionized the field of organ transplants, must be carefully monitored in a patient's blood to regulate the dosage. The test to check the ratio of a therapeutic dose versus a lethal dose is a process that takes six hours. With the new sensor, the blood level of the drug could be immediately detected and deaths could be prevented. Another drug requiring this type of careful regulation is a family of antibiotics known as aminoglycosides.

Some patients metabolize a certain drug quickly and others slowly. Because of this vast variance, there are drugs have not been introduced to the market because of the need for an immediate check of the blood level of the drug in order to prevent death. Plaxco explained that new drugs may be made available when this sensor is applied to this medical use.

To create the sensor, the researchers took a DNA molecule that converts from a floppy and unfolded shape into a structured, folded shape in the presence of cocaine. They then observe the change in the DNA by monitoring how electrons travel through it. There are DNA molecules available that bind to many different targets, so it follows that similar sensors can be easily made for other targets.

Currently the cocaine sensor that is widely used by police is the Scott test. When a chemical is added to the white powder it changes color. But

there are many ways around this test, explained Plaxco, and some cocaine manufacturers add a chemical to block the color change. "Our sensor can detect cocaine no matter what they have cut it with: powdered sugar, flour, or the coffee that is sometimes used to mask the smell from dogs."

At this point the new sensor detects cocaine in the blood or saliva to a degree of a few micromolars. This is equivalent to the concentration of cocaine that would result from dropping a kilogram of cocaine into an olympic-sized swimming pool. That concentration would be the equivalent of detecting three parts per million in blood. Still, this is not yet sensitive enough for use in the emergency room, since a person with .3 parts per million of cocaine in their blood would be considered "stoned on cocaine." So more work needs to be done to increase the sensitivity of the new test.

Last summer was the first time that Plaxco had high school students doing work for academic credit in his lab. "It was great," said Plaxco. "I thought they might be a distraction, but my students and post-doctoral fellows did a great job of mentoring and they all got a lot out of it, both the mentors and the mentorees." First author Brian Baker, a post-doctoral fellow, was one of these mentors.

Elaine Doctor, a senior at Channel Island High School in Oxnard, Calif., and McCall Wood, a senior at Santa Barbara High School in Santa Barbara, Calif., participated in the summertime Research Mentorship Program at UCSB on this work. Elaine Doctor said, "At first I felt kind of intimidated by all the graduate students who are used to all the equipment, but we caught on really fast and everyone was really helpful. I felt honored to help America's war on drugs." Elaine plans to continue her studies in the sciences, either in biochemistry or biology.

McCall Wood said, "I'm really excited about this work. It let me know

what research is like and I definitely want to pursue this. Everyday we would go into the lab and test a different hypothesis. I found it really exciting and extremely challenging. I found my limits, like patience. Being in the lab every day taught me so much about myself and about science in general. It's not really the results that were so important but the journey and the process."

Source: University of California - Santa Barbara