Wearable patch uses ultrasound to track blood pressure inside the body

Researchers have combined wireless and ultrasound technologies to develop a wearable patch that can monitor blood pressure (BP) in arteries deep beneath the skin. This ultrasound patch provides an easy way to help people detect cardiovascular problems earlier on and with greater precision. A team of researchers led by the University of California San Diego describe their work in a paper published in Nature Biomedical Engineering.

Applications include real-time, continuous monitoring of BP changes in patients with heart or lung disease, as well as patients who are critically ill or undergoing surgery. Physicians involved with the study say the technology would be useful in various inpatient procedures.

"This has the potential to be a great addition to cardiovascular medicine," says co-author Dr. Brady Huang, a radiologist at UC San Diego Health. "In the operating room, especially in complex cardiopulmonary procedures, accurate real-time assessment of central blood pressure is needed – this is where this device has the potential to supplant traditional methods."

The device measures central blood pressure in major arteries as deep as four centimetres (more than one inch) below the skin. Central blood pressure is the pressure in the central blood vessels, which send blood directly from the heart to other major organs throughout the body. It differs from the blood pressure that's measured with an inflatable cuff strapped around the upper arm, known as peripheral blood pressure. Medical experts consider central blood pressure more accurate than peripheral blood pressure and also say it's better at predicting heart disease.

The state-of-the-art clinical method for measuring central blood pressure is invasive, involving a catheter inserted into a blood vessel in a patient's arm, groin or neck and guiding it to the heart. A non-invasive method exists, but it can't consistently produce accurate readings. It involves holding a pen-like probe, called a tonometer, on the skin directly above a major blood vessel. To get a good reading, the tonometer must be held steady, at just the right angle and with the right amount of pressure each time. But this can vary between tests and different technicians. Tonometers also require the patient to sit still – which makes continuous monitoring difficult – and are not sensitive enough to get good readings through fatty tissue.

The UC San Diego-led team has developed a convenient alternative – a soft, stretchy ultrasound patch that can be worn on the skin and provide accurate, precise readings of central blood pressure each time, even while the user is moving. And it can still get a good reading through fatty tissue.

The researchers tested the patch on a male subject, who wore it on the forearm, wrist, neck and foot. Tests were performed both while the subject was stationary and during exercise. The patch recordings were more consistent and precise than recordings from a commercial tonometer; these were also comparable to recordings collected with a traditional ultrasound probe.

The patch is a thin sheet of silicone elastomer patterned with what's called an "island-bridge" structure – an array of small electronic parts (islands) that are each connected by spring-shaped wires (bridges). The island-bridge structure allows the entire patch to conform to the skin and stretch, bend and twist without compromising electronic function.

The patch uses ultrasound waves to continuously record the diameter of a pulsing blood vessel inside the body. This information then gets translated into a waveform using customised software.

The researchers note that the patch still has a long way to go before it reaches the clinic. Improvements include integrating a power source, data processing units and wireless communication capability into the patch.

"Right now, these capabilities have to be delivered by wires from external devices. If we want to move this from benchtop to bedside, we need to put all these components on board," explains Sheng Xu, a professor of nanoengineering at the UC San Diego Jacobs School of Engineering and the corresponding author of the study.

The team is looking to collaborate with experts in data processing and wireless technologies for the next phase of the project.

Source: University of California - San Diego
Image credit: Chonghe Wang/ *Nature Biomedical Engineering*

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