Noise-immune stethoscope helps medics hear vital signs in loud environments

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A new type of stethoscope enables doctors to hear the sounds of the body in extremely loud situations, such as during the transportation of wounded soldiers in Blackhawk helicopters. Using ultrasound technology, the kind used to generate images of internal organs, muscles and unborn fetuses, the new stethoscope design will be presented later this week at the Fourth Joint Meeting of the Acoustical Society of American and the Acoustical Society of Japan, which will be held at the Sheraton Waikiki and Royal Hawaiian Hotels in Honolulu, Hawaii.

Researchers at Active Signal Technologies, Inc., of Linthicum Heights, Md., in collaboration with the U.S. Army Aeromedical Research Laboratory (USAARL) in Fort Rucker, Ala., have developed an ultrasound stethoscope that is nearly impervious to loud noise and is capable of making accurate readings at noise levels up to 120 decibels, similar to the volume experienced at the front row of a rock concert.

Current acoustic stethoscope technology picks up and amplifies vibrations that let doctors hear the heart and lungs. These models become difficult to use effectively around 80 decibels, a noise level comparable to an alarm clock or a busy city street. When noise levels reach 90 decibels, these types of stethoscopes are rendered useless. Modern electronic stethoscopes have raised the maximum tolerable noise level to 90 decibels to 95 decibels by replacing the ear pieces with loudspeaker inserts that provide a better seal with the ear canal and replacing the tubing with electrical cables that do not pick up acoustic noise.

The challenge to build a better stethoscope originated from the Army's Small Business Innovation Research program. For soldiers wounded in combat, the first hour after sustaining an injury is known as the "critical hour," when diagnoses and emergency treatment must take place to give them the best chance of recovery. These soldiers are often transported by helicopter, where noise levels prohibit the use of traditional stethoscopes. Auscultation, the act of listening to sounds within the body as a method of diagnosis, is an important tool for assessing the integrity of the heart muscle, valves and major arteries. Auscultation of the lungs can be essential when confirming the placement of endotracheal tubes to restore or protect the airway or when diagnosing conditions such as a collapsed lung, asthma or pulmonary edema.

Houtsma said he is proud of what the research teams were able to accomplish.

"Having heard so much about the first critical hour that may mean life or death for a seriously injured person, I feel fortunate to have been in a position to lead a great team of dedicated researchers in enabling medical auscultation in very noisy environments," Houtsma said. "I expect this invention to save many lives that otherwise might have been lost."

Active Signal Technologies was awarded grants from the Army totaling $900,000 and another $50,000 from the state of Maryland to develop a new type of stethoscope that could be used in high-noise situations. After several unsuccessful attempts to reach the goal of effectiveness at 110 decibels, the idea of using ultrasound technology was implemented.

Traditional stethoscopes transmit and amplify sound that is within the range of human hearing, from about 20 hertz to 20,000 hertz. Most audible sound, including that of the heart and lungs, takes place at around 100 hertz to 200 hertz. The ultrasound models transmit a sound

signal at 2.3 megahertz into the patient's body, according to USAARL stethoscope project team leader Adrian Houtsma. This sound is reflected back to the stethoscope at a slightly different frequency because of the velocity of the internal organs. This is called the Doppler effect. The difference in frequencies between the sound wave that is transmitted and the sound wave that is received can be computed to determine the motion of the internal organs. This difference frequency is then converted into audible sound. Because they are based on different physical principles than conventional stethoscopes, ultrasound models produce a markedly different sound. Where an acoustic stethoscope yields a "lub-dub" sound from a heartbeat, with the first beat being the strongest, an ultrasound stethoscope will yield a "ta-da-ta" pattern, with the second beat being the strongest.

The ultrasound stethoscopes are almost ready to begin the process of FDA approval, which is likely to take two to three months. Then Active Signal Technologies will begin manufacturing the devices to sell to the armed forces. The company's chief executive officer, Arthur Cooke, said the commercial release of the stethoscopes will likely be very small at first, since the cost could be anywhere between $250 and $700. He said he hopes positive feedback from the armed forces will generate widespread interest.

"Once these are seen and implemented," Cooke said, "there will be more commercial interest."

Source: American Institute of Physics