Stanford's Technology Cools Athletes, Soldiers Inside Out

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When people exercise, their muscles consume energy and generate heat as a byproduct. When enough heat accumulates internally, it can limit exercise performance. Two Stanford biologists have developed a method for cooling that maximizes heat transfer through the palms of the hands. The idea is to engorge confluences of arteries and veins located there by mechanically drawing blood into them. The technology was used by some athletes during training for the Olympic Games in Athens, and it may soon find its way into attire for military personnel and others who work in extreme heat.

“We literally cool the body from the inside out, rather than from the outside in, which is the conventional method,” explains Senior Research Scientist Dennis Grahn, who developed the cooling device with H. Craig Heller, the Lorry I. Lokey/Business Wire Professor in Human Biology and Environmental Biology.

The device works by creating a local subatmospheric pressure environment, Grahn says. “We stick the hand in a rigid chamber with an airtight seal around the wrist, and then we draw a bit of the air out of the chamber,” he explains. “This causes blood to be pulled into the hand. Then we cool the overlying skin surface of the palm of the hand [by circulating cool water through a closed system on which the palm of the hand rests], which cools the blood in the hand's vascular heat-exchange structures. Arteries deliver blood directly from the heart to these vascular structures, and veins then carry the blood from these structures back to the heart.”

Grahn and Heller, animal physiologists who specialize in temperature regulation, originally set out to devise a way to eliminate the violent tremors many patients have when they come out of anesthesia after surgery. From studies in rats, the researchers determined that such tremors occur because the body's temperature regulation mechanisms are suppressed during anesthesia. They reasoned that rapid rewarming might stop the tremors sooner. It turns out they were right.

“We used a pressure differential to draw blood to the skin surface, then we applied heat to the skin to increase heat flow back to the core,” Grahn says. “The effect was remarkableÂ—we were able to rewarm people in 10 minutes, down from the typical recovery time of two hours.”

Grahn and Heller went on to develop new technology for treatment of chronic medical conditions where heat sensitivity is a problem, such as multiple sclerosis, and as a way to cool athletes during exercise training. They found that when people used their cooling device during anaerobic exercise, such as weight lifting, where the time to exhaustion is very short, the effects on exercise performance were dramatic. “We helped a weight-lifter increase his capacity to do pull-ups from 180 to 600 in the same time period after six weeks of training,” notes Grahn. “And we've seen professional football players triple their anaerobic exercise capacity in four weeks.”

During aerobic exercise, such as running, conducted in the heat, the device greatly extends endurance. “Under the right circumstances, you can double the endurance of someone working at a fixed load,” says Grahn. “This has significant implications not only for athletes but for people such as factory workers and military personnel who work in hot environments.”

In fact, the Defense Advanced Research Projects Agency, the central

research and development organization for the Department of Defense, now funds development of the technology for potential military use.

“Current methods for keeping military personnel cool just don't work well,” says Grahn. “Military applications will be enormous if the technology can be developed as a glove, much like a bicycling glove, that won't impede fine motor control. We also want to incorporate it into [a] boot in a way that won't impede foot performance. With such devices, you could send a soldier in a chemical protective overgarment out into the desert, where he would normally have a limited survival time, and he could survive indefinitely with peak cognitive function.”

The technology is patented and has been licensed by Stanford's Office of Technology Licensing to AVAcore Technologies Inc., an Ann Arbor, Mich., firm that is developing the device for commercial application.

With this technology, strength, stamina and even quality of life stand to improve for athletes and many others. “Our technology would certainly give athletes a clear competitive edge,” Grahn notes. “We've seen that the rapid increases in strength people get when using the device persist after they stop using it. So, whatever physiological benefit you get, you keep. That's the beauty of it.”