In the battlefield, hemorrhagic shock from combat injuries is the leading cause of death. Here at home, it is one of the leading causes of death among trauma patients as reported by the National Center for Injury Control and Prevention. In the United States, automobile accidents and sports injuries are among its main origins and because its symptoms are internal, the condition is difficult to detect.

Using advanced biomedical signal and image processing combined with machine learning algorithms, associate professor in the department of computer science Kayvan Najarian, Ph.D., is only steps away from launching a consumer-based technological device for early detection of the trauma-induced killer.

Najarian, associate director of Virginia Commonwealth University’s Reanimation Engineering Science Center (VCURES), is working in collaboration with Kevin Ward, M.D., VCURES director and professor of emergency medicine on the MCV Campus, and BodyMedia Advanced Development Inc. in the development of a portable wireless device to assist in the early diagnosis and monitoring of hemorrhagic shock.

“Both in civilian and military trauma cases, it is critical to know about internal bleeding,” Najarian explained. “We can now detect, measure and analyze physiological signals that allow us to determine the presence and severity of internal bleeding.” The technology also allows triage teams and paramedics to locate and track a patient, which is especially significant in battlefield applications.

The analysis of biomedical signals is nothing new—one trip to an emergency room or in an ambulance shows monitors of various designs used to collect data about heart rates and other vital signs. Najarian and his research colleagues, however, are processing and analyzing these signals using computation methods designed specifically for the purpose of identifying hemorrhagic shock and related indicators including its severity.

“We’ve created algorithms to detect and monitor this type of condition and in a much more comprehensive way,” he said. “We’re able to discern whether the signals stem from trauma or from exercise, which often appear to be the same.” The long-term goal of the technology, he explained, is to be able to follow a patient through the healthcare system—from the site of an accident, for example, to the emergency room, to the operating room and beyond.

In an effort to stem the tide of combat fatalities due to hemorrhagic shock, the U.S. Department of Defense (DOD) awarded a Phase I Small Business Technology Transfer award to VCURES and BodyMedia Advanced Development Inc., developer of wearable physical activity and lifestyle monitoring systems, to demonstrate the technology’s capability to detect various states of blood volume loss in a human model of hemorrhage developed by the U.S. Army Institute of Surgical Research.

Success in Phase I led to a DOD Phase II award to continue the work. Najarian and his colleagues have successfully designed and developed a highly technical device for every day use including the measurement of a variety of biomedical signals including oxygen consumption, blood pressure, pulse pressure and stroke volume. From trauma victims to women with high-risk pregnancies, the technology will play a role in the lives of many. “There is even a significant role for rehabilitation and home healthcare,” Najarian said.