

Medical researchers use light to quickly and easily measure blood's clotting properties (w/ Video)

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Defective blood coagulation is one of the leading causes of preventable death in patients who have suffered trauma or undergone surgery. The body's natural defense against severe blood loss is the clotting process, in which platelets, plasma proteins, and other blood components interact to form a sticky, mesh-like structure. But often things go wrong, and blood coagulates too little or too much.

To provide caregivers with timely information about the clotting properties of a patient's blood, researchers at Massachusetts General Hospital have developed an optical device that requires only a few drops of blood and a few minutes to measure the key [coagulation](#) parameters that can guide medical decisions, like how much blood to transfuse or what doses of anticoagulant drugs to administer. The researchers describe their new device in a paper published today in The Optical Society's (OSA) open-access journal *Biomedical Optics Express*.

"Currently, the most comprehensive measures of coagulation are a battery of lab tests that are expensive and can take hours to perform," said Seemantini Nadkarni, an assistant professor at the Wellman Center for Photomedicine at Massachusetts General Hospital and Harvard Medical School and senior author on the *Biomedical Optics Express* paper. She notes that other systems have been developed that provide clotting measurements at the point of care, but the systems can be big and expensive or have other limitations, such as requiring significant

amounts of blood or only measuring clotting time.

"Our goal is to provide as much information as a lab test, but to provide it quickly and cheaply at a patient's bedside," Nadkarni said.

To reach this goal Nadkarni and her colleagues turned to an optical technique they pioneered called laser speckle rheology (LSR). In LSR, researchers shine laser light into a sample and monitor the patterns of light that bounce back. Nadkarni's team had previously used the technique to measure the mechanical properties of a range of different tissue types and found that it was extremely sensitive to the coagulation of blood.

When light hits a blood sample, blood cells and platelets scatter the light. In unclotted blood these light scattering particles move easily about, making the pattern of scattered light, called a speckle pattern, fluctuate rapidly.

"It's almost like looking at a starry night sky, with twinkling stars," Nadkarni said of the speckle pattern. "But as the blood starts to coagulate, [blood cells](#) and platelets come together within a fibrin network to form a clot. The motion is restricted as the sample get stiffer, and the twinkling of the speckle pattern is reduced significantly."

Nadkarni and her team used a miniature high-speed camera to record the fluctuating speckle pattern and then correlated the intensity of changes in the pattern with two important blood sample measurements: clotting time and concentration of fibrinogen, a protein that plays a key role in the clotting process. Doctors in an emergency room or performing surgery could use the measurements to make decisions about how much blood to give a bleeding patient and what type of blood product, for example platelets or fibrinogen, is needed most.

"The timely detection of clotting defects followed by the appropriate blood product transfusion is critical in managing bleeding patients," Nadkarni said. "If you transfuse too much, there could be further coagulation defects that occur, but if you don't transfuse enough, bleeding continues."

On the other end of the spectrum, Nadkarni says the device could also help patients whose blood coagulates too easily, forming clots inside of blood vessels in a condition called thrombosis. These patients take anticoagulation medications and must regularly visit labs to have their blood analyzed and the doses of the medications adjusted. Having a small device that could take the same measurements in a doctor's office or at home could reduce the cost and inconvenience, while increasing the safety of anticoagulation treatment, Nadkarni said.

"I look forward to working on the exciting next phase in which we plan to conduct clinical testing of the LSR device at the point of care in the operating room and in the doctor's office using just a drop or two of blood," said Markandey Tripathi, a postdoctoral fellow at the Wellman Center and lead author on the *Biomedical Optics Express* paper.

"Some other rapid devices exist but these have various disadvantages, ranging from poor correlation with central laboratory tests to skill required to interpret results," added Elizabeth van Cott, who is an associate professor of Pathology at Massachusetts General Hospital and Harvard Medical School, and a co-author on the paper. "The capability of the LSR device to provide rapid test results using small amounts of [blood](#) would be extremely valuable for patients particularly in operating suites, emergency departments, and intensive care units, as well as for any patient with a coagulation disorder."

Currently the optical device developed by Nadkarni and her colleagues is about the size of a tissue box and is connected to a computer. The team

is working to further miniaturize the system and aims to perform clinical studies with a handheld version smaller than a cell phone within the next year.

More information: *Biomedical Optics Express*, Vol. 5, Issue 3, pp. 817 – 831 (2014). [www.opticsinfobase.org/boe/abscfm?uri=boe-5-3-817](http://www.opticsinfobase.org/boe/abs/.../cfm?uri=boe-5-3-817)

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