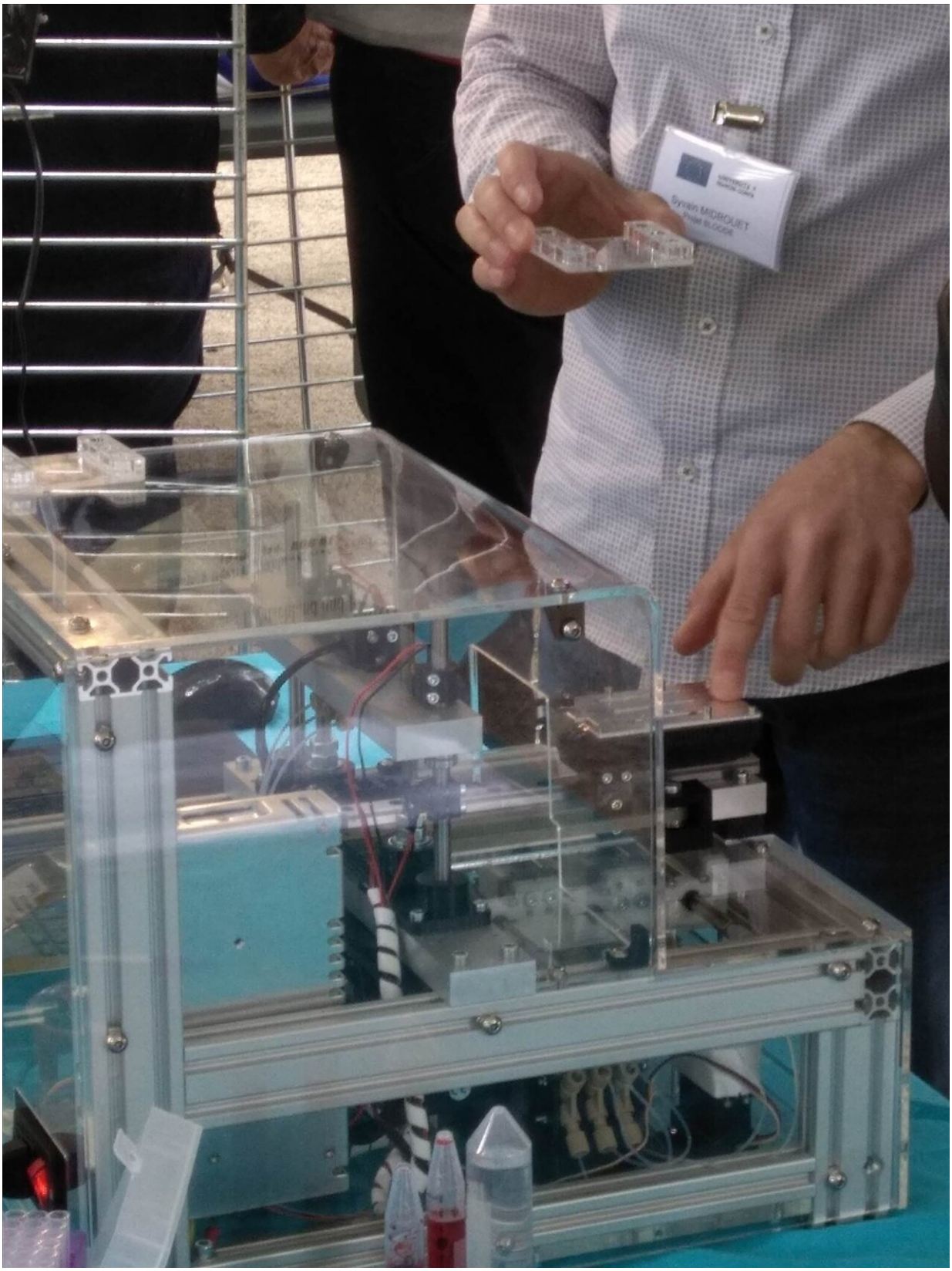
Detecting problems of the anti-bleeding system in 60 minutes

June 21 2019


Sylvain MEDBOUET

The BlooDE device performing platelet work analysis. Credit: Université de Franche-Comté

Various diseases can cause hemorrhages or thromboses, sometimes fatal, resulting in particular from complications during surgery. This may take the form of a dysfunction of the platelets (hemostasis), the blood cells that plug the holes in the damaged blood vessels. Researchers from the University of Geneva (UNIGE), the University of Franche-Comté (UFC) and the Etablissement français du Sang (Bourgogne Franche Comté), have developed a device called BlooDe to study the plugging capacity of platelets.

BlooDe can effectively detect deficient platelet-related hemostasis in advance of an invasive procedure. It artificially reproduces blood circulation and holes in the vessel walls, and can test patient's platelets with sufficient accuracy in under an hour using only a few milliliters of blood.

A failure of the hemostatic system can cause serious bleeding or thrombosis (when the blood no longer flows). In the most severe cases, this can result in the patient's death or outbreaks of bleeding which, although not profuse, are uncomfortable and interfere with daily life. The blood platelets provide the first line of defense against bleeding by quickly plugging the holes in the walls of the blood vessels. Coagulation, as it is properly known, then follows and consolidates the wall; it is this process that is impaired in hemophilia.

It is possible to count the platelets to establish whether they are in sufficient numbers to perform this task. But there is still no good way of determining whether, even if there are enough of them, they are fulfilling their role correctly in the blood as it moves. "Knowing the

hemostatic capacity of a patient is absolutely essential before a medical intervention involving a risk of hemorrhaging," says Thomas Lecompte, a professor in UNIGE's Faculty of Medicine and a doctor in the HUG Department of Medicine.

"A drug treatment can influence this ability either by slowing it down or increasing it, which leads to the risk of hemorrhage or thrombosis respectively. These dangers could be avoided if we knew more precisely how much time is needed for the platelets to plug a hole. But we can't carry out this exploration any more by making a small superficial cut in the skin in the forearm, as was the case for many years."

Device that closely mimics the real conditions of circulating blood

The UNIGE and UFC Franche-Comté scientists joined forces to develop a device to analyze the work of each patient's platelets at speed. "We needed to recreate a system that not only reproduced the movement of liquid blood, but also the holes in the vessel walls," explains Wilfrid Boireau, director of the Department of Micro Nano Sciences and Systems (MN2S) at the FEMTO-ST Institute (UFC—CNRS). When the blood leaves the vessel because of a breach, it encounters elements that were hidden while the vessel was intact (cells and tissues). "These encounters trigger the 'alarm system' that enables the platelets to intervene to plug the hole," says the French researcher.

The scientists created a small device called BlooDe that reproduces the movement of the circulating blood, and into which disposable cartridges are inserted. A pump system circulates the blood so that it can be analyzed in micro-channels built inside the cartridges. "A few milliliters is all that is needed to obtain an informative result," explains professor Lecompte. The blood then circulates in an artificial equivalent of the

damaged vascular wall and the platelets come into play. "Then we need to see how long it takes the platelets to accumulate in this spot in sufficient quantities to stop the bleeding." In an individual without a hemostatic disorder, five minutes is enough. "After 10 minutes, there is a real concern that needs to be factored in when treating the patient."

BlooDe reliably mimics platelet functioning as closely as possible to in vivo processes and provides accurate data about the subject's hemostatic capacity. "In less than an hour, we can have all the information needed to treat the patient properly," says professor Lecompte. In other words, BlooDe fulfills two main functions: In people suffering from a hemostatic system failure, it can be used to identify whether the failure comes from the malfunctioning of the platelets in their natural environment; the hemostatic capacity of individuals scheduled for surgery can be tested so that doctors can administer the appropriate drug therapy to minimize risks.

Pre-series of new prototype envisioned for 2021

The BlooDe prototype has successfully passed its first laboratory tests. In order to consider large-scale clinical validation and commercialization, the researchers are now working on upgrading some of its parts, including the cartridges, and are starting to scale up in preparation for industrial production. It is also currently being used under real medical conditions. "Our goal is to find an intermediary from an industry that specializes in in vivo devices in two years," concludes professor Lecompte.

Provided by University of Geneva