Danger in Numbers

A NEW DIAGNOSTIC TOOL MAY STEM PANDEMICS BY KEEPING THE SICK OUT OF THE HOSPITAL
BY ART JAHNKE

Catherine Klapperich examines a prototype of her “lab on a chip.”
On August 28, 1918, eight sailors at Fort Devens, Massachusetts, suddenly broke out in a cold sweat. Within minutes, their faces flushed red and their body temperature soared. The next day, fifty-eight men at the base displayed the same symptoms. Two days later, eighty-one were infected with what is now known as the flu of 1918, a global pandemic that killed at least twenty million people. Within a few weeks, those who were still alive at Fort Devens would watch as bodies of thousands of dead soldiers were “stacked like cordwood,” according to one account.

What made the flu of 1918 particularly deadly at that and other military bases was the proximity of human hosts. The men lived in close contact, an ideal environment for most influenza viruses. Today, when public health experts imagine how they might combat such a deadly flu, they come up with two strategies. One: kill the virus. And two: keep everyone who may be infected far away from everyone who probably is not infected.

Unfortunately, says Katherine Klapperich, a College of Engineering assistant professor of biomedical engineering, strategy number two is not easily accomplished. When people suspect they may be coming down with the flu, the first thing they want to do is get tested and treated, and that means going to a crowded doctor’s office or hospital and possibly spreading the infection.

For three years, Klapperich has been building a small, inexpensive testing device that could make it unnecessary to travel to a hospital for a diagnosis of flu and many other diseases. Her device, a credit card–sized plastic chip that uses microfluidic action to extract nucleic acids from saliva, blood, and other bodily fluids, was developed with the help of a $2.9 million Translational Partnership Award from the Coulter Foundation. It has the potential to identify a range of problems, from disease-causing bacteria to proteins that may signal a heart attack. It is, in her words, a kind of “lab on a chip” — a lab that can make house calls in the event of a flu outbreak, that doesn’t require refrigeration, and that will eventually provide DNA analysis of disease-causing agents in the field. At the moment, Klapperich says, nucleic acid extraction can be done anywhere, but DNA analysis must be conducted in a lab.

Klapperich’s chip, whose influenza-detecting capabilities are being refined with a grant of nearly $1 million from the National Institutes of Health, would do more than tell health experts who should and should not be treated with a vaccine whose supply may well be limited. It would also give epidemiologists a more precise picture of how such a pandemic is spreading.

Last fall, Klapperich began working with physicians in the emergency department of Boston Medical Center, who send her sample fluids from patients who exhibit flu-like symptoms. Her lab at BU is testing the chip’s ability to extract nucleic acids from several “matrixes,” including blood, stool, urine, saliva, and tears.

“That’s important,” says Klapperich, “because while blood is a great matrix — you can find a lot of diseases in it — you can’t always get blood. In some cultures, taking blood is totally unacceptable. That’s why we have to start looking at things like saliva and tears, at which point we have to ask how much of the organism we’re looking for is going to be found in those fluids.”

In at least one case, she says, the answer is “enough.” Recent research has revealed that the quality of vaginal swabs taken by patients is as reliable as the quality of those taken by physicians, she says. The ability to conduct in-the-field tests of vaginal swabs, as well as of urine, which can yield evidence of sexually transmitted diseases, has powerful implications for public health.

Klapperich is also trying to extract nucleic acids from the bacterium Clostridium difficile. C. difficile, as it is known, is found in the stool and causes infectious diarrhea, a leading killer of children around the world. “In places in the world where an antibiotic is available, it’s important to know which type of infectious diarrhea someone has,” she says. “You need to know if someone has a resistant strain, because you need to get that person away from everyone else. In certain situations, like the military, if you have someone who has a resistant strain, you are really in trouble. This test can tell you that.”