A Blood-Oxygen Detector without Racial Bias

By Simar Bajaj

IDEAS

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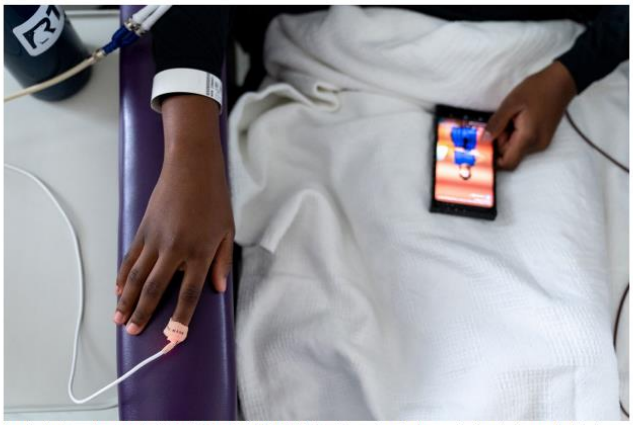
By **Simar Bajaj** Updated July 5, 2022, 12:00 p.m.



A patient with a pulse oximeter in San Antonio in 2020. Britain's health secretary has been reviewing whether medical devices have perpetuated racial and gender biases. ILANA PANICH-LINSMAN/NYT

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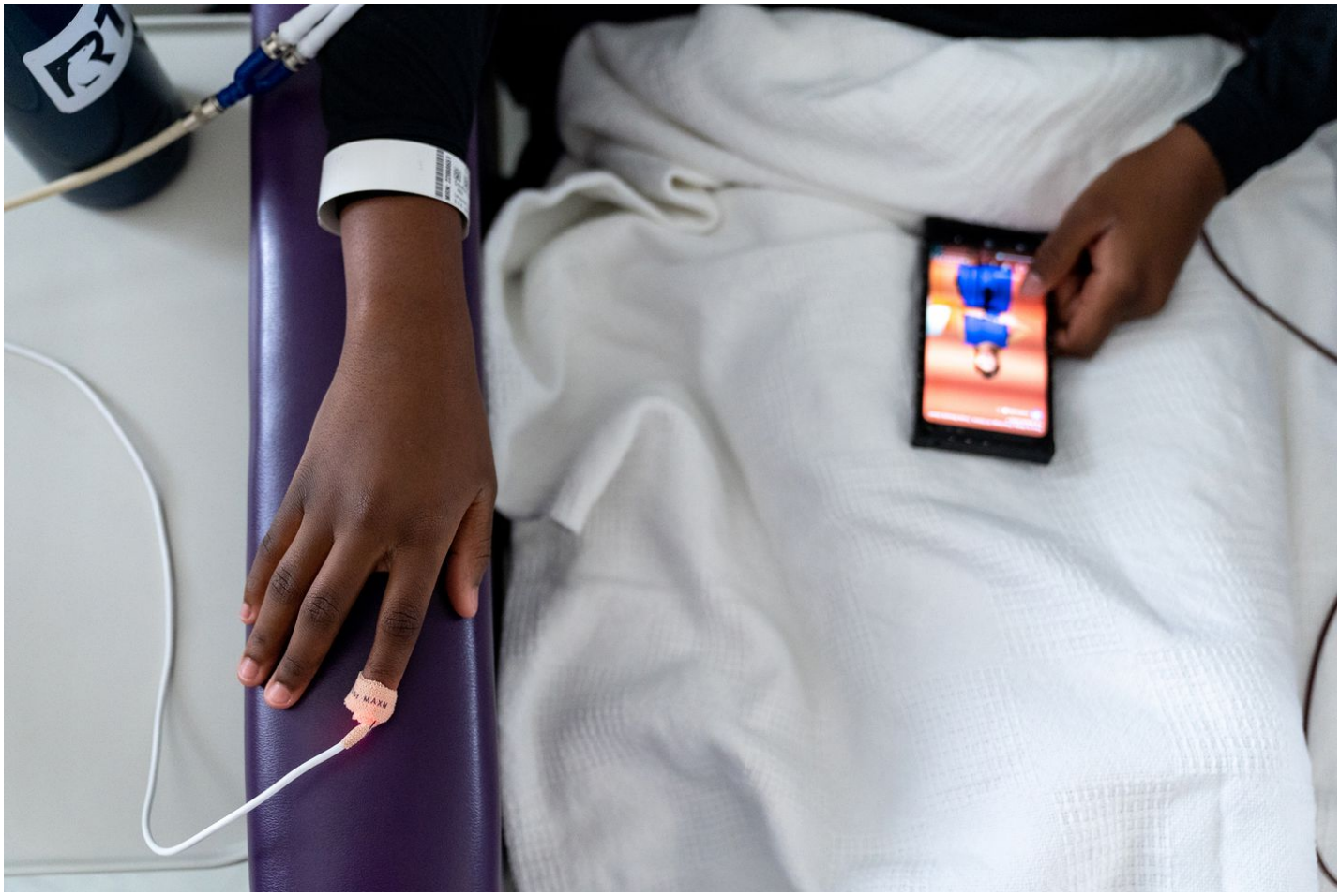


A patient with a pulse oximeter in San Antonio in 2020. Britain's health secretary has been reviewing whether medical devices have perpetuated racial and gender biases. ILANA PANICH-LINSMAN/NYT

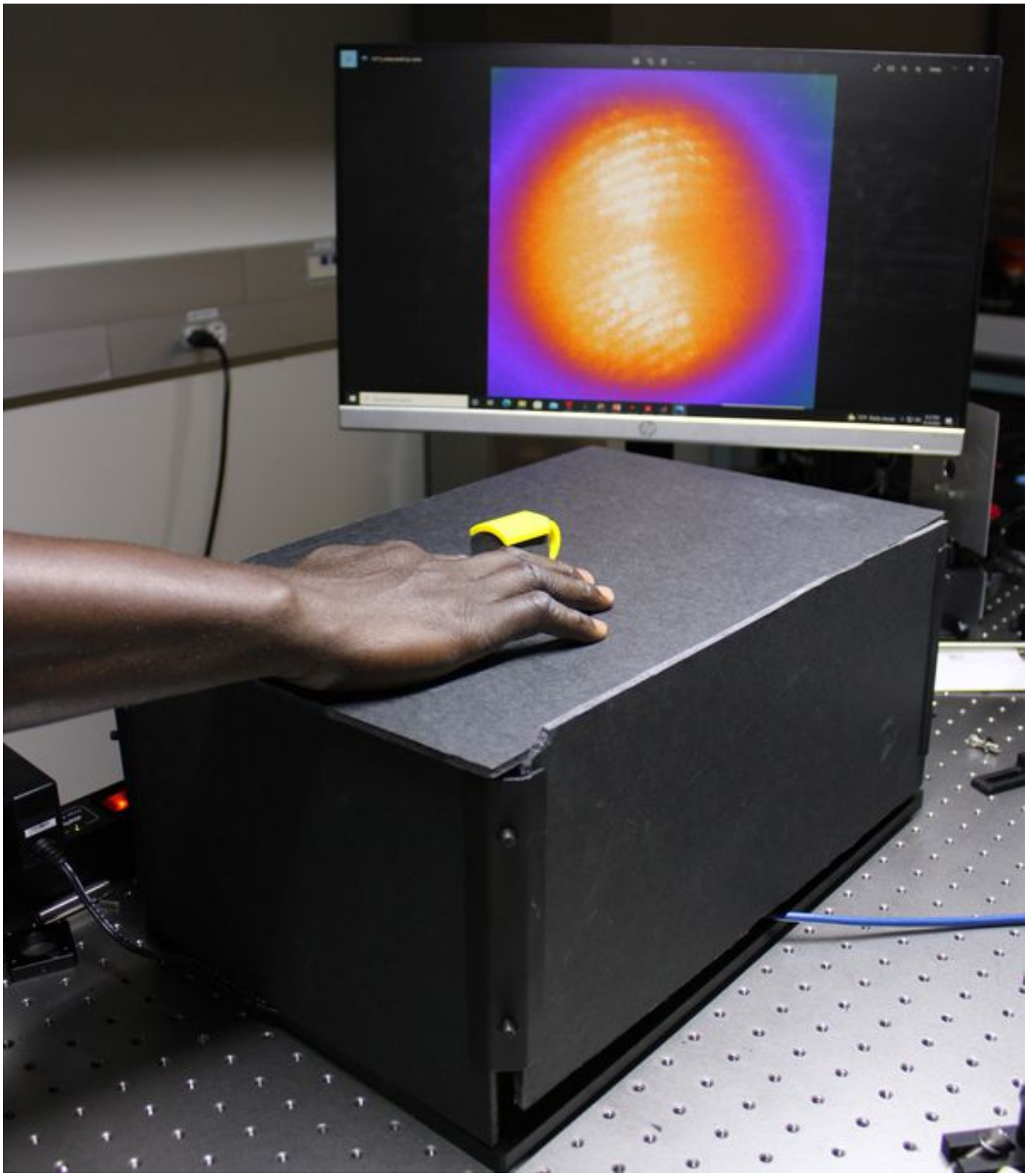
Pulse oximeters, which measure the level of oxygen in your blood, don't always work properly on people with darker skin. One study found that Black patients with critically low oxygen levels were three times more likely to have their level overestimated, which can lead to dangerous delays in care. A more recent study revealed that inaccurate blood-oxygen readouts from Hispanic and Black patients caused them to be about 25 percent less likely to be recognized as eligible for COVID-19 treatment.

It doesn't have to be this way. At Brown University, Rutendo Jakachira, a PhD candidate in physics, and Kimani Toussaint, a professor of engineering, are trying to take racial bias out of oxygen readings by building a better pulse oximeter.

The traditional pulse oximeter is a small clip that attaches to your finger. One side of the clip shoots two wavelengths of light — red and infrared — into the finger while the other side registers how much light was absorbed inside. That reveals the level of oxygen in the blood, because hemoglobin, an iron-containing protein in red blood cells, absorbs infrared light better when it's oxygenated, and it absorbs red light better when it's deoxygenated.

The problem? Hemoglobin is in our arteries and veins, and our skin gets in the way. Everything from tattoos to nail polish to dry skin to wrinkles to melanin can muddle the data.

So Jakachira and Toussaint are devising their oximeter to use a single wavelength of light that bypasses the skin and can be measured from multiple directions. "We're not changing the physics in any way," Toussaint says, "except that we're doing something a little different with how we apply the light." Having completed preliminary testing, they intend to start clinical trials in a couple of months to confirm that their prototype eliminates skin-color bias.



A prototype of the pulse oximeter that Rutendo Jakachira and Kimani Toussaint are developing at Brown University. COURTESY OF KIMANI TOUSSAINT

They actually aren't the first engineers to bring equity to oximetry. In the 1970s, Hewlett-Packard had an oximeter that used eight wavelengths and clipped onto patients' ears. The device was calibrated on Black and white patients, so it was extraordinarily accurate at

measuring oxygen saturation in people from racial and ethnic minorities, says Meir Kryger, a sleep medicine physician and professor at Yale School of Medicine. “It was big and clunky,” Kryger says, “but it was a terrific instrument.” When finger oximeters came onto the market in the 1980s, he ran an experiment comparing a couple of them against HP’s and found that they could not compare in accuracy.

But HP eventually stopped selling medical devices, and Kryger says only less equitable options remained. “We moved backwards because we were mesmerized by being able to do things easy and convenient,” he says. “People always assume the next generation of something is better than the previous.”

There are now other teams working to develop an equitable pulse oximeter. Kryger is a scientific advisor for BodiMetrics, the company behind the circul+ ring, which claims to continuously measure blood oxygen in people of all skin types. The ring does its analysis on the inside of your finger, where there is usually less melanin, and it was tested on Black subjects as well as white ones, according to Kryger. And a group at the University of Washington group is developing an oximeter with a sensor that adjusts for skin tone.

Jakachira and Toussaint are glad to know of these efforts, but they prefer their own approach. Rather than designing a system that accounts for racial bias, Toussaint says, “we are investigating whether the problem could be removed altogether.”

There are steep engineering challenges associated with their goal. “The reality is that there are billion-dollar companies working on this,” Jakachira says, “and you would expect that if it was not technically difficult, then it would have been done by now.” But Toussaint posits that major makers of pulse oximeters haven’t designed equitable devices because it hasn’t been a priority.

“People have known that this is a problem, but they thought that there wasn’t a significant error, or it didn’t matter,” Jakachira says. The pandemic revealed the deadly consequences of neglect.

Simar Bajaj is a student at Harvard University studying the history of science and a research fellow at Massachusetts General Hospital and Stanford University School of Medicine. He has previously written for The Washington Post, New England Journal of Medicine, Nature Medicine, and Lancet.

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