Smartphones could be used to monitor liver disease patients at home

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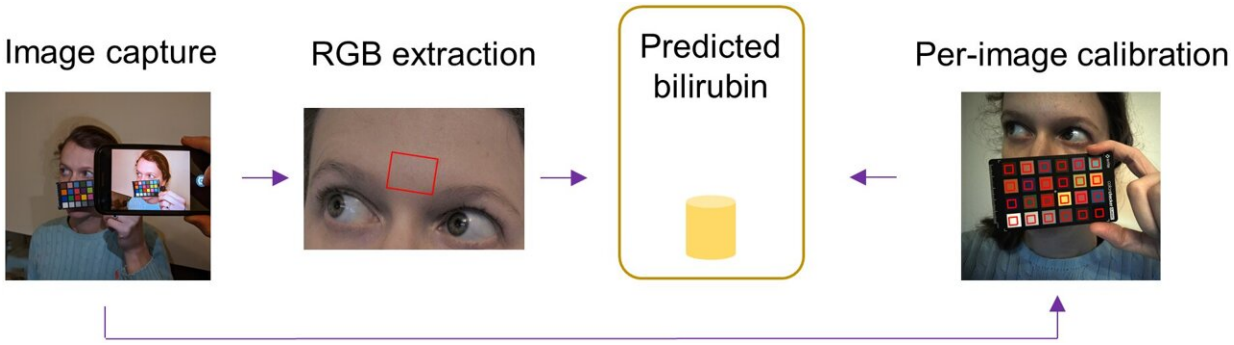

Assessment of bilirubin levels in patients with cirrhosis via forehead, sclera and lower eyelid smartphone images. Credit: *PLOS Digital Health* (2023). DOI: 10.1371/journal.pdig.0000357

A smartphone camera was able to detect changes in skin tone and eye color that require patients to seek medical help, in new research from UCL and the Royal Free Hospital.

The study, published in *PLOS Digital Health*, is the first to assess and compare how smartphone images of the forehead, white of the eye and lower eyelid could be used to accurately predict the bilirubin level of patients with advanced cirrhosis. It found that images of the white of the eye was the best way to predict bilirubin level from an image.

The approach has the potential to monitor liver cirrhosis patients at home more closely, easily and cost effectively than they are currently. The authors expect that this would detect worsening of symptoms before the situation becomes critical, as well as simplify workflows for health care professionals.

Liver disease is the third most common cause of working-age premature death in the UK. While mortality rates have greatly improved for many chronic diseases, the mortality rate for liver disease in the UK increased by 400% between 1970 and 2010. This has increased the need to find non-invasive, cost-effective ways to monitor cirrhosis progression.

Bilirubin is a yellowish pigment that indicates poor liver function when visible in the skin or eye, a condition known as jaundice. Advanced cirrhosis patients' skin and eyes become more yellow as the bilirubin concentration in the blood becomes higher.

Bilirubin levels are currently checked by a blood test performed by a medical professional, which then has to be analyzed. This is usually done in a health care setting. If the level has increased, this indicates that the patient's liver function has deteriorated further and that they need medical help.

In this study, researchers developed a smartphone app that was able to detect the severity of jaundice with a high degree of accuracy. They used a smartphone to take photos of the forehead, white of the eye and lower eyelid of 66 cirrhosis patients. After calibrating the images for lighting conditions, they were analyzed and used to train an algorithm that could predict bilirubin level based on the degree of yellowness in the image.

When these predictions were checked against blood test data, the white of the eye images provided the strongest correlation.

Professor Raj Mookerjee (UCL Medicine), co-author of the study, said, "One of the reasons that liver disease is so challenging is that patients can deteriorate very quickly. It's an unfortunate fact that if a patient arrives at the clinic much more jaundiced than they were previously, the chances are that they have already progressed their disease considerably. The approach that we've assessed in this study could allow us to monitor patients from their own homes much more frequently, than is currently possible and, hopefully, detect worsening of clinical signs and symptoms before things become critical."

One of the challenges the study sought to overcome is the degree of yellowness in patients with cirrhosis, which can be fifty times higher than normal.

"You can look at a patient and tell if they have jaundice right away. But it's a not a question of if the skin looks yellow or not, it's about how much more yellow it looks, which gives you an indication of how badly the liver function has deteriorated," said Professor Mookerjee. "The smartphone app gives us this degree of accuracy. It's a remarkable feat of engineering and shows the power of clinicians and engineers collaborating to solve urgent health care problems."

The next step would be a larger trial to validate the safety and accuracy of the approach. In practice, the approach would likely work by patients frequently taking pictures of their eye via an app, which would inform the clinical care providers of a meaningful change in bilirubin, that might require a change in patient management.

Dr. Terence Leung (UCL Medical Physics & Biomedical Engineering), co-author of the paper, said, "Smartphone camera technology is improving every year, which is allowing us to develop innovative solutions to unmet health care needs using devices that most people have at home. It's great to be able to engineer solutions that are not only cheap

and easy to implement, but which will make a real difference to people's lives."

More information: Miranda Nixon-Hill et al, Assessment of bilirubin levels in patients with cirrhosis via forehead, sclera and lower eyelid smartphone images, *PLOS Digital Health* (2023). DOI: 10.1371/journal.pdig.0000357

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