

SMARTPHONE IMAGE-BASED DETECTION OF LATENT TUBERCULOSIS INFECTION

*Ronald Dendere⁽¹⁾, Tinashe Mutsvangwa⁽¹⁾, Rene Goliath⁽¹⁾, Molebogeng Rangaka⁽²⁾,
Ibrahim Abubakar⁽²⁾, Tania Douglas⁽¹⁾*

⁽¹⁾University of Cape Town, South Africa

rdendere@gmail.com, tinashe@gmail.com, rt.goliath@uct.ac.za, tania.douglas@gmail.com

⁽²⁾University College London, United Kingdom

l.rangaka@ucl.ac.uk, i.abubakar@ucl.ac.uk

Keywords: latent tuberculosis infection, mobile health, computer-aided diagnosis, photogrammetry, image reconstruction

Summary: Latent tuberculosis infection (LTBI) is a sign of previous infection and is associated with high risk of progression to active tuberculosis (TB), particularly in young children. The tuberculin skin test (TST) is the most common method used to detect LTBI. The TST entails intradermal injection of tuberculin purified protein derivative into a patient's arm, followed by assessment of the skin response 48-72 hours later. A positive TST response is a skin induration beyond a size threshold, as typically measured with a ruler. Patients are required to return to health facilities for this measurement to be taken, but many do not, leaving their TST unassessed. We developed and tested a smartphone-based solution for measurement of the skin induration.

The solution included image capture using the primary camera of an HTC One M8 (HTC Corporation, Taiwan) smartphone. The HTC has a 4MP primary camera with a 2µm pixel size, 1/3 inch sensor size and a f/2.0, 28mm lens. A custom-designed rig enabled images to be captured at predetermined positions/angles around the arm. Images were transferred to a personal computer for photogrammetric processing with Agisoft PhotoScan (Agisoft LLC, Russia); this software is able to generate 3D spatial data for indirect measurements of distance, area and volume.

For testing, mock indurations were created on the arms of 10 volunteers by a make-up artist. A scale-bar was placed on the arm prior to image capture for calibration of the capture volume. After 3D reconstruction, image-based measurements were taken by mouse-clicks on the borders of the induration.

Image-based measurements were compared to direct manual measurements by an experienced TST reader. The intra-class correlation coefficient showed excellent agreement (0.96, 95% CI 0.84-0.99). Thus the smartphone based solution shows potential for improving the efficiency of screening for latent TB. We ultimately envision free-hand imaging (without a rig) which could be done by a patient at their home, followed by electronic transfer of images to a central facility. This would remove the need for patients to return to healthcare facilities for assessment of the TST response.