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Comparison of Infrared Thermal Detection Systems for mass fever screening in a tropical healthcare setting

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ABSTRACT

Objectives: Fever screening systems, such as Infrared Thermal Detection Systems (ITDS), have been used for rapid identification of potential cases during respiratory disease outbreaks for public health management. ITDS detect a difference between the subject and ambient temperature, making deployment in hot climates more challenging. This study, conducted in Singapore, a tropical city, evaluates the accuracy of three different ITDS for fever detection compared with traditional oral thermometry and self-reporting in a clinical setting.

Study design: This study is a prospective operational evaluation conducted in the Singapore military on all personnel seeking medical care at a high-volume primary healthcare centre over a one week period in February 2014.

Methods: Three ITDS, the STE Infrared Fever Screening System (IFSS), the Omnisense Sentry MKIII and the handheld Quick Shot Infrared Thermoscope HT-F03B, were evaluated. Temperature measurements were taken outside the healthcare centre, under a sheltered walkway and compared to oral temperature. Subjects were asked if they had fever.

Results: There were 430 subjects screened, of whom 34 participants (7.9%) had confirmed fever, determined by oral thermometer measurement. The handheld infrared thermoscope had a very low sensitivity (29.4%), but a high specificity (96.8%). The STE ITDS had a moderate sensitivity (44.1%), but a very high specificity (99.1%). Self-reported fevers showed good sensitivity (88.2%) and specificity (93.9%). The sensitivity of the Omnisense ITDS (89.7%) was the highest among the three methods with good specificity (92.0%).

Conclusion: The new generation Omnisense ITDS displayed a relatively high sensitivity and specificity for fever. Though it has a lower sensitivity, the old generation STE ITDS system showed a very high specificity. Self-reporting of fever was reliable. The handheld thermograph should not be used as a fever-screening tool under tropical conditions.

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Introduction

The global outbreak of severe acute respiratory syndrome (SARS) in 2003 and the influenza A/H1N1 pandemic in 2009 has led to a proliferation of screening measures that aim to identify cases so that they may be isolated, thereby curbing transmission of respiratory diseases. The presence of fever as a diagnostic criterion for influenza-like illnesses has resulted in the widespread use of fever screening systems for rapid identification of potential cases for public health management.[1–6] As a substantial proportion of affected cases during SARS and the 2009 influenza pandemic had fever as their main symptom,[7] screening systems may identify some of the more severe cases that have a higher propensity for transmission.

Compared to traditional thermometry methods, Infrared Thermal Detection Systems (ITDS) have the advantage of being a time-saving, non-invasive and objective method of fever screening. Despite the widespread use of ITDS (e.g., at hospitals and airports), the initial experience of such systems during SARS suggested a low efficacy.[2,8–11] Since then, there have been further reports on mass screening of fever, with conflicting results.[8,12–19] To date, there are few clinical studies evaluating the various fever screening systems available, or the reliability of self-reported history of fever. As ITDS systems detect a difference between the subject and the ambient temperature, the deployment of these systems is more challenging in hot climates, either in tropical or subtropical regions where year round transmission of respiratory pathogens occurs, or in temperate countries during emerging outbreaks in summer months. This study, conducted in Singapore, evaluates the accuracy of three different ITDS for fever detection compared with traditional oral thermometry and self-reporting in a clinical setting.

Methods

Singapore is a tropical city in South-East Asia with diurnal daily temperatures of 23 °C and 34 °C. This study is a prospective operational evaluation conducted in the Singapore military on all personnel seeking medical care at a high-volume primary healthcare centre from 10 to 14 Feb 2014.

Device selection

Three ITDS—the STE Infrared Fever Screening System (IFSS) (Singapore Technologies Electronics, Singapore), the Omnisense Sentry MKIII (Omnisense Systems Ptd Ltd, Singapore) and the handheld Quick Shot Infrared Thermoscope HT-F03B (Shenzhen WTYD Technology Limited, Guangdong, China)—were evaluated. The STE ITDS was the first thermal imager based system in the world designed for mass human temperature screening, developed and deployed during the SARS outbreak of 2003.[20] The basic setup consists of a mounted thermal imager which uses a Thermal Reference Source (TRS) as a reference to display the temperature profile of the subject. Temperature is represented as an illustration of different colours on a real-time monitor, each of which corresponds to a particular temperature, and the user interprets a febrile subject based on the hot spots on the subject's skin surface (see Fig. 1A). The Omnisense Sentry MKIII is similar in setup to the STE IFSS, and has been marketed as a new generation ITDS with real-time calibration to ambient temperature with a claimed 0.1 °C accuracy. It also has a video capture device that is digitally synchronized to the thermal image, with a dual video display which sets off an automated alarm and visual auto-tracking of the target once a febrile subject enters the screening area (see Fig. 1B). It is in widespread use in various commercial buildings and hospitals locally. The Quick Shot Infrared Thermoscope is a handheld thermal scanner which displays the estimated core body temperature after it is directed a few centimetres from a subject's forehead, and is also widely used in the Singapore military, primary healthcare settings and childcare centres due to its portability and non-intrusiveness.

Participants and eligibility

Subjects who sought medical care at a high-volume primary healthcare centre in the military were included. The evaluation was conducted from 8:00 AM to 3:00 PM every day, as the majority of patients consulted in the morning. Eligible

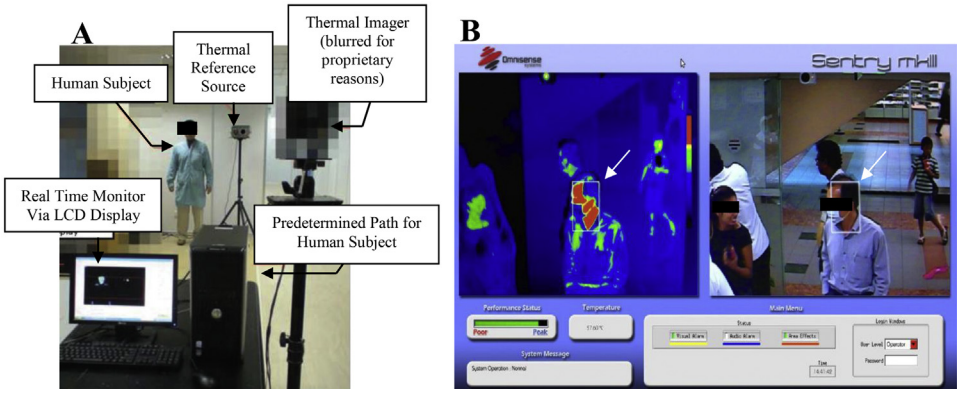

Fig. 1 – Basic ITDS Setup and the Omnisense Dual Video Monitor. (A) shows the STE ITDS, which illustrates the basic setup of the ITDS, with the STE ITDS video monitor in the foreground. (B) shows the Omnisense ITDS video monitor with auto-tracking of febrile subjects (white arrows).