Journal of Infection (2010) **60**, 271—277

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A novel screening method for influenza patients using a newly developed non-contact screening system

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Accepted 20 January 2010
Available online 4 February 2010

KEYWORDS
Non-contact;
Screening;
Infection;
Pandemic influenza;
Microwave radar;
Thermography;
Heart rate;
Respiratory rate

Summary *Objectives:* In places of mass gathering, rapid infection screening prior to definite diagnosis is vital during the epidemic season of a novel influenza. In order to assess the possibility of clinical application of a newly developed non-contact infection screening system, we conducted screening for influenza patients.
Materials and methods: The system is operated by a screening program via a linear discriminant analysis using non-contact derived variables, i.e., palmar pulse derived from a laser Doppler blood-flow meter, respiration rate determined by a 10-GHz microwave radar, and average facial temperature measured by thermography. The system was tested on 57 seasonal influenza (2008—2009) patients (35.7 °C $\leq$ body temperature $\leq$ 38.3 °C, 19—40 years) and 35 normal control subjects (35.5 °C $\leq$ body temperature $\leq$ 36.9 °C, 21—35 years) at the Japan Self-defense Forces Central Hospital.
Results: A significant linear discriminant function ($p < 0.001$) was determined to distinguish the influenza group from the control group (Mahalanobis D-square = 6.5, classification error rate > 10%). The system had a positive predictive value (PPV) of 93%, which is higher than the PPV value (PPV $\leq$ 65.4%) reported in the recent summary of studies using only thermography performed mainly in hospitals.

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doi:10.1016/j.jinf.2010.01.005

Conclusions: The proposed system appears promising for application in accurate screening for influenza patients at places of mass gathering.

Introduction

A novel influenza A virus, subtype H1N1 of swine-lineage (H1N1 swl) has circulated throughout the world rapidly.[1] In mass gathering places, such as, hospital outpatient units, airport quarantine facilities, and public health centers, prior to definite diagnosis, rapid screening of infection is urgently needed during the epidemic season of a novel influenza.[2] In order to conduct fast screening of people with infections, such as pandemic influenza, severe acute respiratory syndrome (SARS),[3] or other emerging infectious diseases, we have developed a non-contact screening system to perform human medical inspections within several tens of seconds, from non-contact derived heart and respiratory rates, as well as facial temperature measured by a non-contact method. A number of countries have applied thermography at international airports in order to detect infectious passengers. A previous study revealed that the positive predictive value (PPV) varied from 3.5% to 65.4%.[4] This low PPV indicates the limited effectiveness of thermography in detecting early-stage influenza symptoms.

As a result of infection, not only body temperature but also heart and respiratory rates increase. Therefore, in order to achieve more accurate screening, heart and respiratory rates are used as new parameters for screening. We conducted non-contact influenza screening within 30 s using the newly developed screening system. The system is operated by the screening program through a linear discriminant analysis using non-contact derived variables, i.e., palmar pulse determined using a laser Doppler blood-flow meter, respiration rate determined using a 10-GHz microwave radar, and average facial temperature measured by thermography. We have previously demonstrated the possibility of non-contact determination of exposure to toxic conditions via a 1215-MHz microwave radar,[5,6] which has been investigated for use in locating human subjects buried under earthquake rubble,[7–9] in order to prevent secondary exposure of medical personnel to toxic materials under biochemical hazard conditions. Exposure to a toxin, namely, lipopolysaccharide,[10] was determined by linear discriminant analysis using non-contact derived variables in an animal experiment.[5] In a previous study, we assessed the performance of the newly developed non-contact screening system in a laboratory from an engineering viewpoint.[11] In the present paper, for seasonal influenza (2008—2009) patients and normal control subjects, we investigate whether the newly developed screening system can distinguish influenza patients from normal control subjects at the Japan Self-defense Forces Central Hospital.

Materials and methods

Non-contact screening system for medical inspection

The technical details of the non-contact screening system have been reported in a previous paper.[11] The non-contact

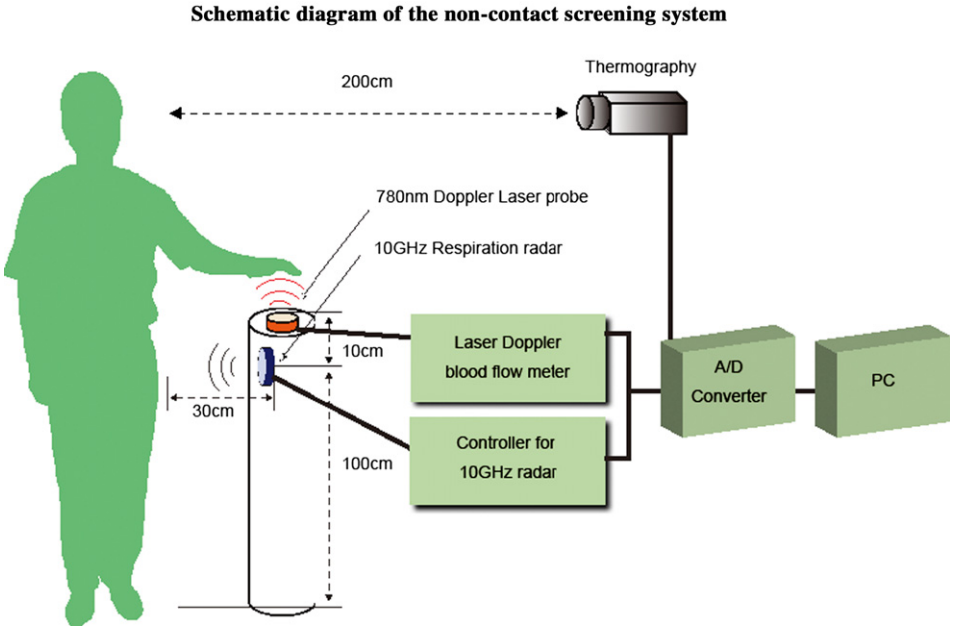

Figure 1 The system is operated by a screening program via a linear discriminant analysis using non-contact derived variables, i.e., palmar pulse determined using a laser Doppler blood-flow meter, respiration rate determined using a 10-GHz microwave radar, and average facial temperature measured by thermography.