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# Computer-aided detection of Severe Acute Respiratory Syndrome (SARS) on chest radiography

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**Abstract.** Severe Acute Respiratory Syndrome (SARS) is a newly described infection affecting, in most individuals, the lungs with progressive severe pneumonia. It is highly contagious and has a high mortality rate. It is unresponsive to antibiotics and the main methods of control involve barrier isolation. Because of these features, early diagnosis is required for control of the disease. Unlike other forms of severe pneumonia, the initial presenting chest radiograph may not disclose the pneumonia. A computer-aided detection system has been developed that marks locations on chest radiographs of minimal areas of pneumonia. It has been tested on a small series of chest radiographs with minimal SARS pneumonia and provided 88% sensitivity with 1.3 false-positive marks per image. © 2004 CARS and Elsevier B.V. All rights reserved.

*Keywords:* SARS; Computer-aided detection; Chest radiography

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## 1. Introduction

Severe Acute Respiratory Syndrome (SARS) is a newly described infection affecting, in most individuals, the lungs with progressive severe pneumonia. It is highly contagious and has a high mortality rate. It is unresponsive to antibiotics and the main methods of control involve barrier isolation. Because of these features, early diagnosis is required for control of the disease. Unlike other forms of severe pneumonia, the initial presenting chest radiograph may not disclose the pneumonia. Recent reports from three sites indicate that of

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218 affected individuals, the chest radiograph was positive for pneumonia on the initial chest radiograph in 164 (75%) (range 60–80%) and without evidence of pneumonia in 54 (25%) (range 20–40%) [1–3]. This is distinct from other forms of severe pneumonia; for example, with *Legionella* pneumonia, only 1% of initial chest radiographs are reported to be without evidence of pneumonia [4–9].

Deus Technologies, LLC (Rockville, MD, USA) developed a computer-aided detection (CAD) system for the detection of minimal pneumonia (RapidScreen: RS-SARS). This paper reports on the results of initial tests of this system on cases of probable SARS pneumonia. Cases included met the criteria of the World Health Organization criteria for probable SARS. At present, RS-SARS is not FDA approved.

## 2. Materials and methods

Chest radiographs of 59 patients with probable SARS were collected from multiple sources in Asia. Each case had one or more films obtained 1 day to 3 weeks after onset of fever. The chest radiographs were from computed radiography (CR), digital radiography (DR) and film digitizers. A radiologist reviewed each film to select those that showed minimal disease. Of the 59 patients, 24 had at least one early radiograph that was considered to be either normal or to have minimal disease.

## 3. Results

Early SARS demonstrates several patterns including poorly defined rounded airspace lesions, airspace disease of subsegmental size and airspace disease of segmental size. Of 24 cases with focal or multifocal (but not diffuse) disease, 21 had true positive (TP) machine detections (88%). For these 24 cases, there were 35 true-positive (TP) and 31 false-positive (FP) locations marked, an average of 1.3 FP marks per image.

A subset of these cases with one or two small foci of disease was also evaluated. 12 of these had one small focus and two had two small foci. Of these 16 foci, 15 were detected by the RS-SARS providing a sensitivity of 94%, with 1.1 false-positive detections per image.

The detection performance on CR, DR, and digitized chest radiographs is similar.

## 4. Discussion

SARS pneumonia with its high degree of contagion and moderate mortality rate showed itself in 2003 to be a severe public health problem. Early detection is the key to containment. In this process of early detection, the chest radiograph is used as the primary screening method for people presenting with symptoms of potential SARS pneumonia. The preliminary study presented demonstrates the potential of a computer-aided diagnosis system to detect minimal areas of pneumonia. This system could assist radiologists in the detection of early SARS pneumonia.

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