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SARS AND ITS IMPACT ON CURRENT AND FUTURE EMERGENCY DEPARTMENT OPERATIONS

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□ **Abstract—A long-standing concern for international spread of new, virulent pathogens became a reality with the advent of Severe Acute Respiratory Syndrome (SARS). This respiratory syndrome, caused by a coronavirus, spread rapidly across 30 nations since its first recognition in late 2002. SARS has presented the greatest recent threat to U.S. public health, and has come at a time when purposeful introduction of pathogens by terrorists is also of heightened concern. SARS has forced the international medical establishment to reexamine how best to manage such incidents. © 2004 Elsevier Inc.**

□ **Keywords—severe acute respiratory syndrome; SARS; respiratory; emergency medicine; EMS; biological; mass casualty**

INTRODUCTION

[1]For many years, public health experts have predicted the advent and rapid transit of epidemics via international travel and commerce. A long-standing concern for the introduction of new pathogens to the United States became real during the migration of the West Nile Virus in the summer of 2002, and was accentuated by the unexpected emergence of Severe Acute Respiratory Syndrome (SARS). Since the first cases in the Guangdong province of China in November 2002, and Vietnam, Hong Kong, and Canada in February 2003, SARS has been reported in nearly 30 different countries (1). As of October 2003, SARS has afflicted more than 8000 individuals and caused 774 deaths worldwide (2). In the United States, there have been as many as 164 cases, but no reported fatalities thus far (3). SARS is the first new disease to necessitate involuntary quarantine measures in the United States since 1983 (4,5).

As the emergence and progression of SARS and similar epidemics have occurred rapidly, printed medical journals have been increasingly challenged to keep pace with developments, and health care professionals are now increasingly utilizing the World Wide Web for up-to-date information (6). SARS also underscores the need for a more coordinated effort from the medical community, including increased communication, integration of multiple departments and services, and an enhanced system of biosurveillance (7).

Though SARS has been on the decline in human populations since July 2003, there is growing concern that the syndrome may reemerge as colder weather sets in (8,9). Because Emergency Departments (EDs) are primary portals of access to health care, Emergency Physicians will be responsible for the identification and safe management of new SARS cases, and thus need education about the condition. The emergence of SARS suggests that the ED may need to be an increased resource in public health policy and management.

[1] The opinions expressed in this article are those of the authors and do not reflect the official policy of the Department of the Army, Department of Defense, or the U. S. Government.

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Table 1. CDC Case Definition Criteria for SARS*

Clinical criteria
Asymptomatic or mild respiratory illness
Moderate respiratory illness
Temperature of > 100.4°F (> 38°C), and
One or more clinical findings of respiratory illness (e.g., cough, shortness of breath, difficulty breathing, or hypoxia).
Severe respiratory illness
Temperature of > 100.4°F (> 38°C), and
One or more clinical findings of respiratory illness (e.g., cough, shortness of breath, difficulty breathing, or hypoxia), and radiographic evidence of pneumonia, or respiratory distress syndrome, or autopsy findings consistent with pneumonia or respiratory distress syndrome without an identifiable cause
Epidemiologic criteria
Travel (including transit in an airport) within 10 days of onset of symptoms to an area with current or recently documented or suspected community transmission of SARS, or
Close contact within 10 days of onset of symptoms with a person known or suspected to have SARS infection
Laboratory criteria
Confirmed
Detection of antibody to SARS-associated coronavirus (SARS-CoV) in a serum sample, or
Detection of the SARS-CoV RNA by RT-PCR confirmed by a second PCR assay, by using a second aliquot of the specimen and a different set of PCR primers, or
Isolation of SARS-CoV
Negative
Absence of antibody to SARS-CoV in a convalescent-phase serum sample obtained >28 days after symptom onset.
Undetermined
Laboratory testing either not performed or incomplete
Case classification
Probable case: meets the clinical criteria for severe respiratory illness of unknown etiology and epidemiologic criteria for exposure; laboratory criteria confirmed or undetermined.
Suspect case: meets the clinical criteria for moderate respiratory illness of unknown etiology, and epidemiologic criteria for exposure; laboratory criteria confirmed, negative, or undetermined
Exclusion criteria
A case may be excluded as a suspect or probable SARS case if:
An alternative diagnosis can fully explain the illness.
The case has a convalescent-phase serum sample (i.e., obtained > 28 days after symptom onset) that is negative for antibody for SARS-CoV.
The case was reported on the basis of contact with an index case that was subsequently excluded as a case of SARS, provided other possible epidemiologic exposure criteria are not present.

* As of July 18, 2003 (17).

EPIDEMIOLOGY

Two laboratories have identified the infectious agent of SARS independently as a coronavirus (10). The members of Coronaviridae are large, enveloped RNA viruses that cause diseases in humans and domestic animals. Disease caused by a coronavirus was first described in 1931; human coronaviruses were first identified in the 1960s (11). Little attention previously had been paid to these pathogens due to their relatively innocuous nature. Previously described species include HCV-229E and HCV-OC43, both of which cause respiratory infections. Although coronaviruses primarily infect respiratory mucosa, they also have been demonstrated in gastrointestinal mucosa (12). This may explain the gastrointestinal symptoms noted in nearly 20% of SARS cases (13).

A key pathogenic feature of Coronaviridae is the high frequency of RNA recombination, which allows for rapid mutation and evolution (14). Human coronaviruses are also relatively resilient, retaining infectivity for as long as 6 days in suspension and 3 h after drying on surfaces (15). Previous coronavirus-associated respiratory diseases have incidences ranging from 5.1–18%, and, in many cases, are associated with preexisting pulmonary or cardiac disease (16–18). Mortality from such infections has been associated with advanced age and immunocompromised status (19,20).

CLINICAL PRESENTATION

The incubation period of SARS was initially estimated at 2 to 7 days (21), however, some cases support an interval of up to 16 days between exposure and symptoms; the median incubation period in the Hong Kong case series published by Lee et al. was 6 days (13). As with most viral illnesses, clinically differentiated SARS is preceded by a prodrome of nonspecific symptoms. SARS cases were initially defined by four criteria that were subsequently modified by the Centers for Disease Control and Prevention (CDC) on July 18, 2003 (Table 1) (21,22).

Common features of the prodrome include chills, rig-

ors, myalgias, headache, and malaise. Less common to the prodrome are mild respiratory symptoms, nausea, vomiting, and diarrhea. Rash and lymphadenopathy have not yet been reported (13,21). Three to seven days after the onset of prodromal symptoms, the lower respiratory phase develops, heralded by dyspnea, non-productive cough, and hypoxia. In severe cases, respiratory failure develops, necessitating mechanical ventilation, and causing mortality in approximately 9% of cases thus far. The mortality rate for patients admitted with SARS is related to age and comorbidities, with the elderly and those with diabetes or cardiac disease at increased risk (13,23). Patients presenting with compatible symptoms should be questioned about possible travel to endemic regions; barring close contact with a SARS-suspect patient, this is the current *sine qua non* of diagnosis, though this may change as cases become more widespread.

Radiographic findings may be non-specific or absent (21). The CDC Preliminary Clinical Description included focal interstitial infiltrates that progress to generalized interstitial infiltrates, and late consolidation (21), whereas the Lee et al. Hong Kong series reported early, focal airspace consolidation in a high proportion of patients, with all patients developing airspace opacities at some point during the illness (13). A recent retrospective review of chest radiographs in confirmed SARS cases revealed an initial abnormality in 78.3% of cases. The most suggestive findings included peripheral location of infiltrates, progression from unilateral focal to bilateral or multifocal airspace opacities, and lack of cavitation, lymphadenopathy, and pleural effusions (24). As the case definition also includes a reference to Acute Respiratory Distress Syndrome (ARDS) without clear source, any compatible chest radiograph in the timeframe of an ongoing epidemic should be considered consistent with a diagnosis of SARS (22).

Laboratory findings available in the acute setting are non-specific. Many patients will manifest a moderate leukopenia and/or thrombocytopenia (21). Of the leukocyte lines, lymphocytes tend to be the most prominently suppressed (13,21). More specific laboratory evidence of SARS may be sought in the form of serum antibodies to the SARS-associated coronavirus in the serum, or by detection of viral RNA in respiratory samples by reverse transcriptase polymerase chain reaction (25). Although several international companies are developing rapid laboratory tests, these assays are not currently available for use in ED decision-making. Recent evidence also suggests that mutation of the SARS virus could impact laboratory identification of cases as well as the utility of a single vaccine (26).

Overall, it seems prudent to recommend that patients meeting clinical criteria for SARS have pulse oximetry, chest radiograph, and a complete blood count with differential included in their ED workup. Though the findings of these tests are not diagnostic, they may be supportive of a diagnosis of SARS, and thereby may mandate serological testing, which could be done once the patient is in isolation.

TREATMENT

Due to the recent nature of the SARS outbreak, there has not been sufficient time to identify an effective treatment. Several existing treatment regimens have met with anecdotal success. Ribavirin has been the most studied agent among these, however, there is not enough conclusive data to support its widespread use (27). Human interferons have shown early promise as either a primary or adjunctive therapy, but further testing is needed (28). Large-scale prospective research studies have yet to be completed. Furthermore, as with HIV, the rapid mutation of the coronavirus and the evolution of several strains may frustrate the development of a specific vaccine for some time (21). As a result, current treatment for SARS consists primarily of supportive care, including mechanical ventilation as needed.

IMPACT ON PREHOSPITAL CARE

Previously, exposure to airborne pathogens has been a minor concern due to the relatively low rate of tuberculosis and a lack of significant untreatable airborne illnesses. SARS has now forced a change in thinking. Due to its relatively high infectivity, SARS may present a significant risk to the pre-hospital provider (29). Assisted ventilation, endotracheal intubation, and close provider-patient proximity in the back of ambulances account for this increased risk (30). Even before the arrival of SARS, some first responders were reluctant to provide mouth-to-mouth assisted ventilations, even with a barrier device (31). The potential presence of an infection like SARS can be expected to make first responder intervention less likely. Current CDC guidelines recommend full personal protective equipment (PPE), outlined below, for the transport of any known SARS patient. Unfortunately, this diagnosis may not be known during the initial evaluation (32). Further research is needed toward developing respiratory devices to protect the pre-hospital provider while allowing for adequate airway management.

IMPACT ON THE EMERGENCY DEPARTMENT

During peak ED flow, “well-appearing” patients often experience delays before full triage assessment. In a SARS patient, this delay potentially allows the patient to

contaminate the waiting room and infect others. As suggested by Schull and Redelmeier, the presence of a single unrecognized SARS patient in a crowded ED may have created the epicenter of an outbreak (33). During a period of SARS outbreak or concern, triage protocols should be modified so that any patient with a respiratory complaint or fever is immediately asked about travel to areas with community transmission of SARS as well as any exposure to a patient with suspected or probable SARS (34). Placing signs at all ED entrances with instructions to go directly to the triage nurse if either of these contact criteria are met may further reduce the risk of waiting room contamination. If either of those conditions is met, the patient should then put on a surgical mask and be moved immediately to a negative pressure isolation room, if available. Registration and assessment may then continue after ED personnel employ CDC-recommended PPE: gown, gloves, N95 respirator, and eye protection (35). Strict hand washing also must be exercised (34). Health care providers with PPE can then proceed in determining if the patient meets criteria for SARS (22). All used PPE should be discarded in biohazard receptacles and all reusable equipment should be properly sanitized (32). Once disposition of a SARS patient is completed, a terminal cleaning of the room should be done with standard hospital disinfectant (36).

The decision to involuntarily quarantine a patient for suspected SARS will require serious consideration as well as some adjustments to normal ED operations. The Department of Health and Human Services (HHS) has granted involuntary quarantine authority to the U.S. Coast Guard, U.S. Customs Service, and individual state health departments (5). This authority was exercised for a tourist with SARS symptoms who was involuntarily held for 10 days in the State of New York as well as for an airline passenger returning to Minnesota from the Philippines through San Francisco (37,38). The HHS guidelines were then inactivated in June 2003, due to the cessation of new human cases (39). The power to quarantine rests with government officials, but because the ED is the primary portal of entry to most hospitals, it is logical to surmise that the ED would become a major site of any quarantine action should the guidelines need to be reactivated.

Another difficulty in managing SARS patients in the ED is how to protect the health care team while caring for the critically ill patient. Nebulizer treatments and the coughing the patient produces increase the production of infectious droplets (32). Isolation rooms are not universally available. When available, they often do not allow close observation, and may be too small for urgent interventions such as central venous access or airway control. As such, they may not be practical for a critically ill SARS patient. At present, the most prudent solution is to place the patient in an appropriate resuscitation room as far from patient flow as possible, use of full PPE for all involved personnel, and post-resuscitation cleaning as outlined above. In the future, there may be an increasing trend toward respiratory isolation rooms with telemetry and video monitoring capabilities.

Perhaps the most significant issue for Emergency Medicine with regards to the SARS outbreak is the potential for a mass casualty situation and subsequent overwhelming of ED resources. With current CDC guidelines, the key discriminator that separates a patient with potential SARS from a multitude of other ED patients with respiratory complaints is the travel or exposure history. If widespread community transmission occurs in the United States, then it will become exceedingly difficult to separate out the SARS cases. Likely this will be combined with a much greater number of patients presenting without SARS but with similar symptoms and heightened concern for what their symptoms represent. One solution may be placing all patients with any historical concern for SARS in any available isolation measure, even if this means possibly mixing those with and without SARS. Other less attractive alternatives include more stringent triage guidelines, which may prolong the movement of suspected patients out of the waiting room, or the use of isolation rooms throughout the hospital for triage to minimize the mingling of patients, which may contaminate other sections of the hospital. Any overwhelming or shutdown of a hospital, as has already occurred in Beijing, will increase the burden on the remaining local EDs as well as adversely affect those patients who will have to seek their medical care elsewhere (40).

Although many details about SARS transmission are not yet known, thus hindering the development and implementation of specific actions, new general measures should be considered and adopted. One of the lessons learned from Hong Kong is the importance of a strong and coordinated response by the health care community (41). Individual health departments, Emergency Medical Services (EMS) base stations, and individual hospitals should form local protocols to conserve resources as well as to minimize confusion and error during an actual event. Prehospital protocols should direct potential SARS cases to the hospitals best able to evaluate and treat these cases. Other factors to consider in forming protocols include: availability of isolation rooms in the ED and hospital, Intensive Care Unit (ICU) capabilities, diversion contingency plans, inventories and supply of PPE and medications, periodic interdepartmental tabletop exercises, regular review of the hospital disaster plan, crowd and media control, security, notification of public health and government officials, and new laboratory capabilities as they become available.

CONCLUSION

Over the past year, SARS has adversely affected millions of people and cost international economies hundreds of billions of dollars. It has frustrated public health officials and stymied research efforts. Recent successes have occurred in controlling the SARS epidemic despite the lack of specific details; primarily through general health measures and coordinated public health policies. Although the United States has thus far escaped the brunt of the SARS outbreak, the experiences of other affected countries have raised numerous concerns about our ability to respond to this rapidly emerging infection. SARS is both a considerable ongoing threat and a harbinger of the increasing incidence, scope, and virulence of emerging infections that the American public and emergency personnel will continue to face in the 21st century.

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