

Severe Acute Respiratory Syndrome

Subjects: Agriculture, Dairy & Animal Science

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Severe acute respiratory syndrome (SARS) is a viral respiratory disease of zoonotic origin caused by the SARS coronavirus (SARS-CoV). Between November 2002 and July 2003, an outbreak of SARS in southern China caused an eventual 8,098 cases, resulting in 774 deaths reported in 37 countries, with the majority of cases in China and Hong Kong (9.6% fatality rate) according to the World Health Organization (WHO). No cases of SARS have been reported worldwide since 2004. In late 2017, Chinese scientists traced the virus through the intermediary of civets to cave-dwelling horseshoe bats in Yunnan province.

Keywords: health ; sars ; sars-cov

1. Signs and Symptoms

Initial symptoms are flu-like and may include fever, muscle pain, lethargy symptoms, cough, sore throat, and other nonspecific symptoms. The only symptom common to all patients appears to be a fever above 38 °C (100 °F). SARS may eventually lead to shortness of breath and pneumonia; either direct viral pneumonia or secondary bacterial pneumonia.

The average incubation period for SARS is 4–6 days, although rarely it could be as short as 1 day or as long as 14 days.

2. Cause

The primary route of transmission for SARS is contact of the mucous membranes with respiratory droplets or fomites. Whilst diarrhoea is common in people with SARS, the fecal-oral route does not appear to be a common mode of transmission.^[1] The basic reproduction number of SARS, R_0 , ranges from 2 to 4 depending on different analyses. Control measures introduced in April 2003 reduced this down to 0.4.^[1]

3. Diagnosis

SARS may be *suspected* in a patient who has:

- Any of the symptoms, including a fever of 38 °C (100 °F) or higher, and
- Either a history of:
 1. Contact (sexual or casual) with someone with a diagnosis of SARS within the last 10 days *or*
 2. Travel to any of the regions identified by the World Health Organization (WHO) as areas with recent local transmission of SARS.

For a case to be considered *probable*, a chest X-ray must be positive for atypical pneumonia or respiratory distress syndrome.

The WHO has added the category of "laboratory confirmed SARS" for patients who would otherwise be considered "*probable*" but who have not yet had a positive chest X-ray changes, but have tested positive for SARS based on one of the approved tests (ELISA, immunofluorescence or PCR).^[2]

The appearance of SARS in chest X-rays is not always uniform but generally appears as an abnormality with patchy infiltrates.^[3]

4. Prevention

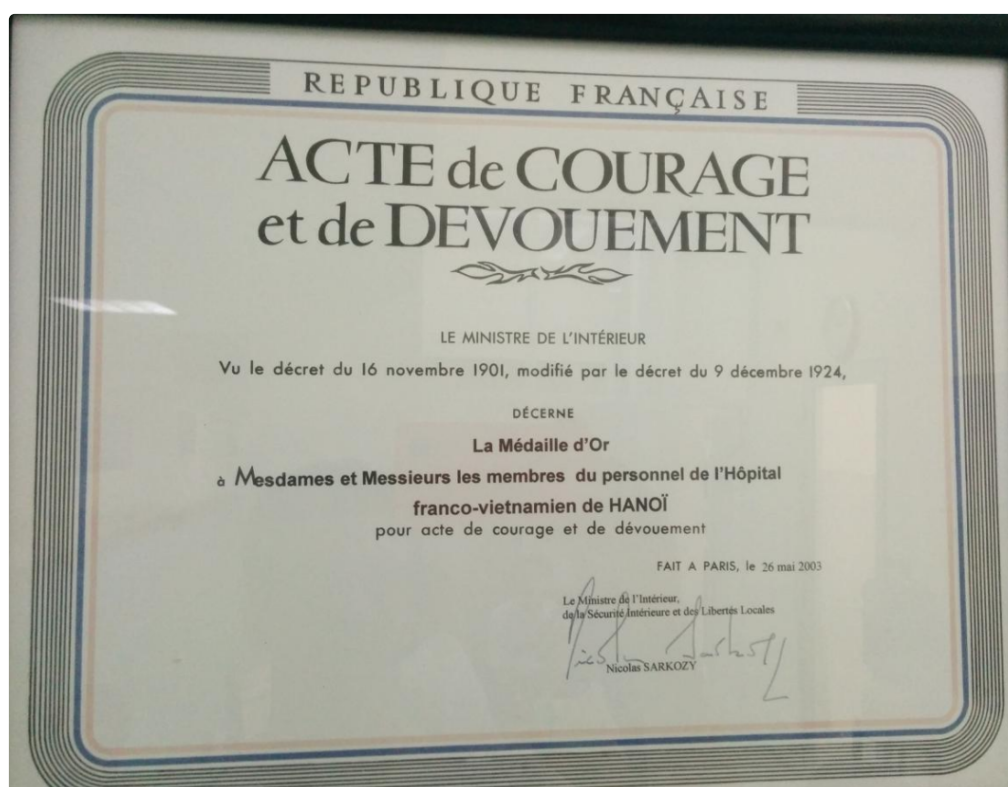
There is no vaccine for SARS. Isolation and quarantine remain the most effective means to prevent the spread of SARS. Other preventative measures include:

- Hand-washing
- Disinfection of surfaces for fomites
- Wearing a surgical mask
- Avoiding contact with bodily fluids
- Washing the personal items of someone with SARS in hot, soapy water (eating utensils, dishes, bedding, etc.)^[4]
- Keeping children with symptoms home from school
- Simple hygiene measures
- Isolating oneself as much as possible to minimise the chances of transmission of the virus

Many public health interventions were made to try to control the spread of the disease, which is mainly spread through respiratory droplets in the air. These interventions included earlier detection of the disease; isolation of people who are infected; droplet and contact precautions; and the use of personal protective equipment (PPE), including masks and isolation gowns.^[5] A screening process was also put in place at airports to monitor air travel to and from affected countries.^[6] Although no cases have been identified since 2004, the CDC is still working to make federal and local rapid response guidelines and recommendations in the event of a reappearance of the virus.^[7]

SARS is most infectious in severely ill patients, which usually occurs during the second week of illness. This delayed infectious period meant that quarantine was highly effective; people who were isolated before day five of their illness rarely transmitted the disease to others.^[1]

5. Treatment



Award to the staff of the Hôpital Français de Hanoï for their dedication during the SARS crisis.

<https://handwiki.org/wiki/index.php?curid=1416426>

Antibiotics are ineffective, as SARS is a viral disease. Treatment of SARS is mainly supportive with antipyretics, supplemental oxygen and mechanical ventilation as needed. Antiviral medications are used as well as high doses of steroids to reduce swelling in the lungs.

People with SARS must be isolated, preferably in negative pressure rooms, with complete barrier nursing precautions taken for any necessary contact with these patients, to limit the chances of medical personnel getting infected with SARS.

Some of the more serious damage caused by SARS may be due to the body's own immune system reacting in what is known as cytokine storm.^[8]

As of 2017, there is no cure or protective vaccine for SARS that has been shown to be both safe and effective in humans.^[9] The identification and development of novel vaccines and medicines to treat SARS is a priority for governments and public health agencies around the world. MassBiologics, a non-profit organization engaged in the discovery, development

and manufacturing of biologic therapies, is cooperating with researchers at NIH and the CDC in developing a monoclonal antibody therapy that demonstrated efficacy in animal models.^{[10][11][12]}

6. Prognosis

Several consequent reports from China on some recovered SARS patients showed severe long-time sequelae. The most typical diseases include, among other things, pulmonary fibrosis, osteoporosis, and femoral necrosis, which have led to the complete loss of working ability or even self-care ability of these cases. As a result of quarantine procedures, some of the post-SARS patients have been documented suffering from posttraumatic stress disorder (PTSD) and major depressive disorder.^{[13][14]}

7. Epidemiology

SARS was a relatively rare disease; at the end of the epidemic in June 2003, the incidence was 8422 cases with a case-fatality rate of 11%.^[5]

The case-fatality ratio ranges from 0% to 50% depending on the age group of the patient.^[4] Patients under 24 were least likely to die; those 65 and older were most likely to die.^[15]

8. History

Probable cases of SARS by country and region, 1 November 2002 – 31 July 2003.				
Country or Region	Cases	Deaths	SARS cases dead due to other causes	Fatality (%)
Canada	251	44	0	18
China, People's Republic of *	5,328	349	19	6.6
Hong Kong	1,755	299	5	17
Macau	1	0	0	0
Taiwan **	346	37	36	11
Singapore	238	33	0	14
Vietnam	63	5	0	8
United States	27	0	0	0
Philippines	14	2	0	14
Mongolia	9	0	0	0
Kuwait	1	0	0	0
Republic of Ireland	1	0	0	0
Romania	1	0	0	0
Russian Federation	1	0	0	0
Spain	1	0	0	0
Switzerland	1	0	0	0
South Korea	4	0	0	0
Total	8273	775	60	9.6
(*) Figures for the People's Republic of China exclude Hong Kong and Macau, which are reported separately by the WHO.				
(**) Since 11 July 2003, 325 Taiwanese cases have been 'discarded'. Laboratory information was insufficient or incomplete for 135 discarded cases; 101 of these patients died.				
Source: World Health Organization. ^[16]				

8.1. Outbreak in South China

The viral outbreak can be genetically traced to a colony of cave-dwelling horseshoe bats in China's Yunnan province.^[17]

The SARS epidemic appears to have started in Guangdong Province, China in November 2002 where the first case was reported that same month. The patient, a farmer from Shunde, Foshan, Guangdong, was treated in the First People's Hospital of Foshan. The patient died soon after, and no definite diagnosis was made on his cause of death. Despite taking some action to control it, Chinese government officials did not inform the World Health Organization of the outbreak until February 2003. This lack of openness caused delays in efforts to control the epidemic, resulting in criticism of the People's Republic of China from the international community. China has since officially apologized for early slowness in dealing with the SARS epidemic.^[18]

The outbreak first appeared on 27 November 2002, when Canada's Global Public Health Intelligence Network (GPHIN), an electronic warning system that is part of the World Health Organization's Global Outbreak Alert and Response Network (GOARN), picked up reports of a "flu outbreak" in China through Internet media monitoring and analysis and sent them to the WHO. While GPHIN's capability had recently been upgraded to enable Arabic, Chinese, English, French, Russian, and Spanish translation, the system was limited to English or French in presenting this information. Thus, while the first reports of an unusual outbreak were in Chinese, an English report was not generated until 21 January 2003.^{[19][20]} The first super-spreader, Zhou Zuofen (named incorrectly as Zhou Zoufeng in the citation) was admitted to the Sun Yat-sen Memorial Hospital in Guangzhou on January 31, which soon spread the disease to nearby hospitals.^[21]

Subsequent to this, the WHO requested information from Chinese authorities on 5 and 11 December. Despite the successes of the network in previous outbreak of diseases, it did not receive intelligence until the media reports from China several months after the outbreak of SARS. Along with the second alert, WHO released the name, definition, as well as an activation of a coordinated global outbreak response network that brought sensitive attention and containment procedures.^[22] By the time the WHO took action, over 500 deaths and an additional 2,000 cases had already occurred worldwide.^[20]

In early April, after Jiang Yanyong pushed to report the danger to China,^{[23][24]} there appeared to be a change in official policy when SARS began to receive a much greater prominence in the official media. Some have directly attributed this to the death of American James Earl Salisbury.^[25] It was around this same time that Jiang Yanyong made accusations regarding the undercounting of cases in Beijing military hospitals.^{[23][24]} After intense pressure, Chinese officials allowed international officials to investigate the situation there. This revealed problems plaguing the aging mainland Chinese healthcare system, including increasing decentralization, red tape, and inadequate communication.

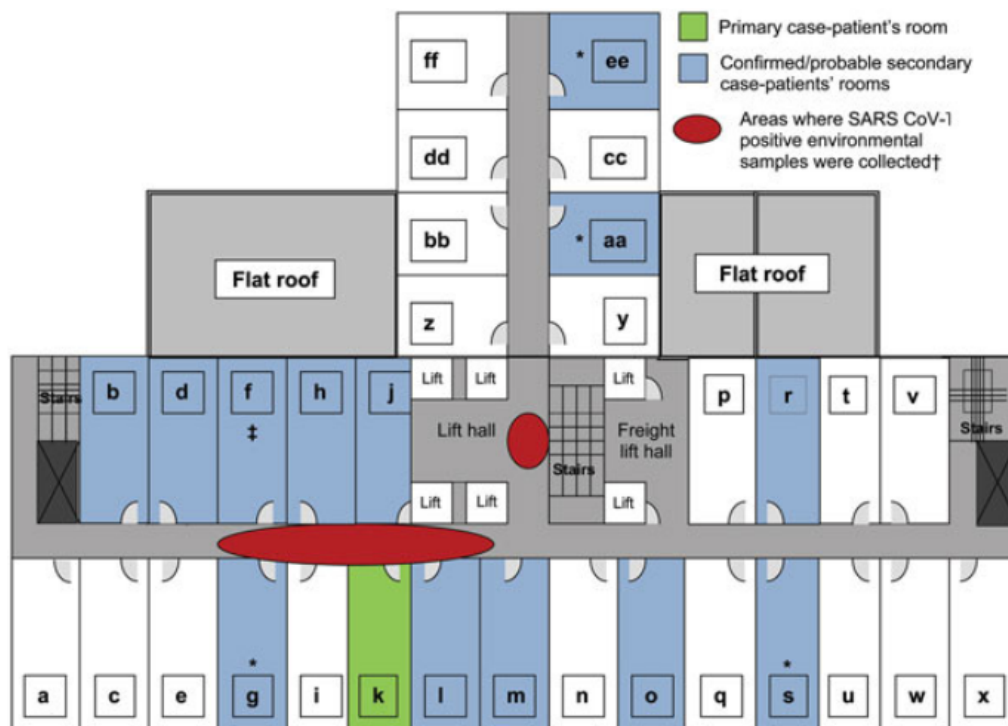
Many healthcare workers in the affected nations risked and lost their lives by treating patients and trying to contain the infection before ways to prevent infection were known.^[26]

8.2. Spread to Other Countries and Regions

The epidemic reached the public spotlight in February 2003, when an American businessman traveling from China, Johnny Chen, became afflicted with pneumonia-like symptoms while on a flight to Singapore. The plane stopped in Hanoi, Vietnam, where the victim died in Hanoi French Hospital. Several of the medical staff who treated him soon developed the same disease despite basic hospital procedures. Italian doctor Carlo Urbani identified the threat and communicated it to WHO and the Vietnamese government; he later succumbed to the disease.^[27]

The severity of the symptoms and the infection among hospital staff alarmed global health authorities, who were fearful of another emergent pneumonia epidemic. On 12 March 2003, the WHO issued a global alert, followed by a health alert by the United States Centers for Disease Control and Prevention (CDC). Local transmission of SARS took place in Toronto, Ottawa, *San Francisco*, Ulaanbaatar, Manila, Singapore, Taiwan, Hanoi and Hong Kong whereas within China it spread to Guangdong, Jilin, Hebei, Hubei, Shaanxi, Jiangsu, Shanxi, Tianjin, and Inner Mongolia.

Hong Kong



9th floor layout of the Hotel Metropole in Hong Kong, showing where a super-spreading event of severe acute respiratory syndrome (SARS) occurred. <https://handwiki.org/wiki/index.php?curid=1548050>

The disease spread in Hong Kong from Liu Jianlun, a Guangdong doctor who was treating patients at Sun Yat-Sen Memorial Hospital.^[28] He arrived in February and stayed on the ninth floor of the Metropole Hotel in Kowloon, infecting 16 of the hotel visitors. Those visitors traveled to Canada, Singapore, Taiwan (Republic of China), and Vietnam, spreading SARS to those locations.^[29]

Another larger cluster of cases in Hong Kong centred on the Amoy Gardens housing estate. Its spread is suspected to have been facilitated by defects in its drainage system. Concerned citizens in Hong Kong worried that information was not reaching people quickly enough and created a website called sosick.org, which eventually forced the Hong Kong government to provide information related to SARS in a timely manner.^[30] The first cohort of affected people were discharged from hospital on 29 March 2003.^[31]

Toronto

The first case of SARS in Toronto, Canada was identified on February 23, 2003.^[32] Beginning with an elderly woman, Kwan Sui-Chu, returning from a trip to Hong Kong, the virus killed her on March 5 and eventually infected 257 individuals in the province of Ontario. The trajectory of this outbreak is typically divided into two phases, the first centring around her son Tse Chi Kwai, who infected other patients at the Scarborough Grace Hospital and died on March 13. The second major wave of cases was clustered around accidental exposure among patients, visitors, and staff within the North York General Hospital. The WHO officially removed Toronto from its list of infected areas by the end of June, 2003.^[33]

The official response by the Ontario provincial government and Canadian federal government has been widely criticized in the years following the outbreak. Brian Schwartz, vice-chair of Ontario's SARS Scientific Advisory Committee, described public health officials' preparedness and emergency response at the time of the outbreak as "very, very basic and minimal at best".^[34] Critics of the response often cite poorly outlined and enforced protocol for protecting healthcare workers and identifying infected patients as a major contributing factor to the continued spread of the virus. The atmosphere of fear and uncertainty surrounding the outbreak resulted in staffing issues in area hospitals when healthcare workers elected to resign rather than risk exposure to SARS.

8.3. Identification of Virus

The CDC and Canada's National Microbiology Laboratory identified the SARS genome in April 2003.^{[35][36]} Scientists at Erasmus University in Rotterdam, the Netherlands demonstrated that the SARS coronavirus fulfilled Koch's postulates thereby confirming it as the causative agent. In the experiments, macaques infected with the virus developed the same symptoms as human SARS victims.^[37]

In late May 2003, studies were conducted using samples of wild animals sold as food in the local market in Guangdong, China. The results found that the SARS coronavirus could be isolated from masked palm civets (*Paguma* sp.), even if the animals did not show clinical signs of the virus. The preliminary conclusion was the SARS virus crossed the xenographic barrier from asian palm civet to humans, and more than 10,000 masked palm civets were killed in Guangdong Province. The virus was also later found in raccoon dogs (*Nyctereuteus* sp.), ferret badgers (*Meilogale* spp.), and domestic cats. In 2005, two studies identified a number of SARS-like coronaviruses in Chinese bats.^{[38][39]}

Phylogenetic analysis of these viruses indicated a high probability that SARS coronavirus originated in bats and spread to humans either directly or through animals held in Chinese markets. The bats did not show any visible signs of disease, but are the likely natural reservoirs of SARS-like coronaviruses. In late 2006, scientists from the Chinese Centre for Disease Control and Prevention of Hong Kong University and the Guangzhou Centre for Disease Control and Prevention established a genetic link between the SARS coronavirus appearing in civets and humans, bearing out claims that the disease had jumped across species.^[40]

In December 2017, "after years of searching across China, where the disease first emerged, researchers reported ... that they had found a remote cave in Yunnan province, which is home to horseshoe bats that carry a strain of a particular virus known as a coronavirus. This strain has all the genetic building blocks of the type that triggered the global outbreak of SARS in 2002." The research was "published in the journal *Public Library of Science Pathogens*" and "was led by Shi Zheng-Li and Cui Jie of the Wuhan Institute of Virology, China... In their paper, the Chinese team warn that another deadly outbreak of SARS could emerge at any time. As they point out, the cave where they discovered their strain is only a kilometre from the nearest village."^[41]

8.4. Containment

The World Health Organization declared severe acute respiratory syndrome contained on 9 July 2003. In the following years, four SARS cases were reported in China between December 2003 and January 2004. There were also three separate laboratory accidents that resulted in infection. In one of these cases, an ill lab worker spread the virus to several other people.^{[42][43]} Study of live SARS specimens requires a BSL-3 facility; some studies of inactivated SARS specimens can be done at BSL-2 facilities.^[44]

9. Society and Culture

9.1. Community Response

Fear of contracting the virus from consuming infected wild animals resulted in public bans and reduced business for meat markets throughout southern China and Hong Kong.^[45] In China, Cantonese foodways, which often incorporate a wide range of meat sources, were frequently indicted as an important contributing factor to the origins of the SARS outbreak.

Toronto's Asian minority population faced increased discrimination over the course of the city's outbreak. Local advocacy groups reported Asians being passed over by real-estate agents and taxi drivers and shunned on public transportation.^[46] In Boston and New York City, rumors and April Fools pranks gone awry resulted in an atmosphere of fear and substantial economic loss in the cities' Chinatowns.

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