2003 Severe Acute Respiratory Syndrome (SARS) Epidemic: A One Health Perspective

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Abstract

Background: The 2003 Severe Acute Respiratory Syndrome (SARS) outbreak was a global epidemic that affected 8,098 individuals and resulted in 774 deaths by March 2003. Originating in Guangdong, China in late November 2002, this virus quickly crossed international borders to nearby countries like Hong Kong and Singapore and traveled as far as the United States. Patients infected with SARS suffered from severe respiratory symptoms that ranged from dry coughs to severe forms of pneumonia. Initial medical teams and community members in Guangdong had little to no information on the new strain of coronavirus. This gap in information and lack of medical resources combined with slips in surveillance from the Chinese federal government and public health officials facilitated the rapid spread of SARS that led to detrimental repercussions.

A One Health approach that utilizes human, animal, and environmental disciplines may have improved the surveillance and treatment of SARS. With this interdisciplinary approach, public health officials could have better educated and trained medical communities and the general public to ensure that these infectious diseases do not emerge while humans and animals increasingly interact with the environment.

Purpose: The purpose of this paper is to (1) present the epidemiology of the 2003 SARS outbreak (2) identify lessons learned from the 2003 SARS outbreak, and (3) explore the role of One Health in addressing the SARS outbreak.

Introduction

The coronavirus refers to a single-stranded RNA virus covered in glycoprotein spikes that can mutate in around 40 different forms (Aronson, 2020). Known for infecting both humans and non-humans, coronaviruses can easily spread from animal to human. There are seven types of human coronaviruses to date that all vary in severity from the common cold to severe respiratory infections (Virginia Department of Health, 2020). Scientists and the rest of the world witnessed the severity of coronavirus in humans during the 2003 Severe Acute Respiratory Syndrome (SARS) Epidemic. This is comparable to the more novel, deadly strain of coronavirus, COVID-19, in the ongoing global pandemic that currently has 40 million worldwide cases as of October 20, 2020 after the initial outbreak in Wuhan, China in late 2019 (Johns Hopkins University, 2020)**.** Both SARS and COVID-19 have witnessed rapid transmission rates via respiratory droplets and severe respiratory infections but SARS had a much higher case fatality ratio (Khafaie & Rahim 2020). This manuscript highlights how the 2003 SARS Epidemic occurred on a smaller scale than COVID-19 but had far reaching effects.

Severe Acute Respiratory Syndrome (SARS)

The 2003 outbreak of Severe Acute Respiratory Syndrome was an international epidemic that affected over 8,098 individuals among which 774 died (Centers for Disease Control and Prevention, 2017). In other words, this deadly acute respiratory disease killed 1 in 10 people infected from November 2002 to July 2003 (National Health Services, 2019). SARS is caused by the SARS coronavirus (SARS-CoV) that contributed to the wide range of symptoms patients experience 2-10 days within exposure. Infected individuals began with a high fever over 100.4^0F before experiencing headaches, body aches, diarrhea, dry coughs, and the eventual development of pneumonia (Mayo Clinic, 2019). The route of transmission includes person-to-person contact through respiratory droplets,

contaminated surfaces, and airborne spread that allows SARS to spread rapidly from an infected individual to the surrounding environment.

As SARS began to gain international attention by early 2003, travel bans, and isolation protocols were quickly put into place in Asian and American countries by the government and by health institutions such as the World Health Organization (WHO) and Centers for Disease and Control and Prevention (CDC). During this time, health professionals reported the elderly population were at a higher risk for the airborne disease due to weaker or compromised immune systems. By the end of the epidemic, more than half of the infected individuals who were 65 years or older had succumbed to SARS (National Health Services, 2019). Since the 2003 outbreak, there has been no reported cases of SARS and while there was no official treatment developed, ongoing research continues. The aftermath of SARS gave an urgency to public health institutions to strengthen their response systems for similar outbreaks (Hung, 2003). This paper serves to (1) present the epidemiology of the 2003 SARS outbreak (2) identify lessons learned from the 2003 SARS outbreak, and (3) explore the role of One Health in addressing the SARS outbreak.

2003 SARS Epidemic

The SARS outbreak began in mainland China, specifically Guangdong, before spreading to other parts of the world including Hong Kong, United States, and Canada (Centers for Disease Control and Prevention, 2013). Guangdong is the southernmost mainland portion of China surrounded by the South China Sea and connected to Hong Kong and Macau (Yeung & Chang, 2016). Historically, Guangdong has had a unique physical and cultural environment that separates itself from the rest of China. This may have contributed to the quick, yet hidden, spread of SARS. Early reports during the start of this worldwide epidemic came from cities in Guangdong like Foshan, Heyuan, and Zhongshan as physicians, in mid-November 2002, noticed abnormal patient cases of atypical pneumonia (Huang,

2004). Yet, Chinese health officials did not receive reports of these patients until a month later when health experts were sent to local hospitals. These patients were then diagnosed with an "infection-based disease" and this information began to slowly move through the chain of command from the local Guangdong hospitals to the Ministry of Health in Beijing (Huang, 2004). By January 2003, the virus was spreading among the public without their knowledge as health officials withheld information from the public and medical community (Huang, 2004).

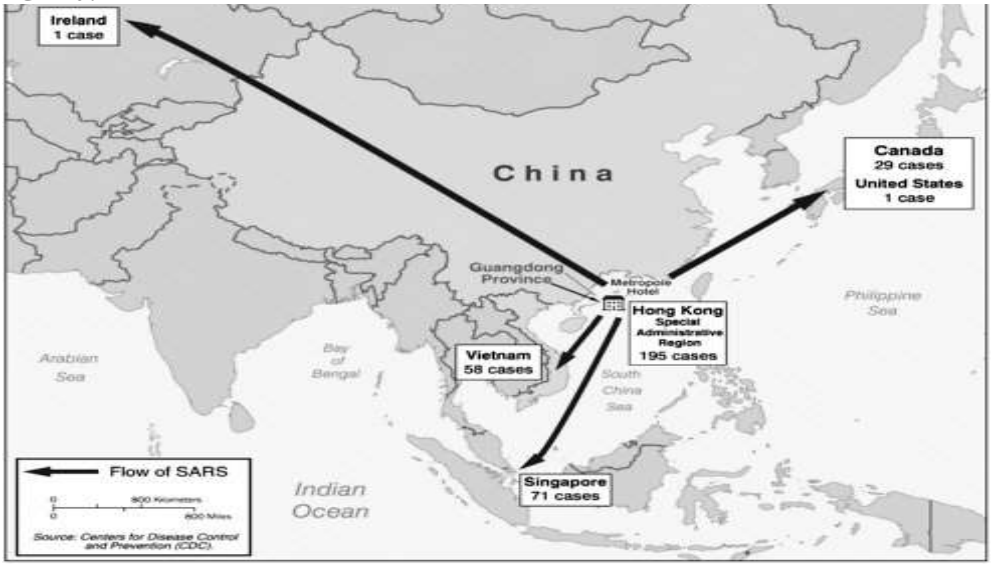
The rapid spread of SARS can be traced to the initial phase of the outbreak. With a lack of public information, doctors and nurses continued to treat patients with the reported "infectious disease" (Huang, 2004). Health care workers were the first to get infected which allowed the virus to be easily transmitted among other health care staff and inevitably, the larger community (Thompson et al., 2003). This pattern of transmission was observed in several regions of southern China as abnormal cases began to rapidly appear in the surrounding provinces. No travel bans were issued at this point which meant infected individuals were unknowingly traveling to outside countries and transmitting the disease across borders all over the world.

In mid-February 2003, the WHO was finally informed of the rising numbers of patients with atypical pneumonia (Gittings & Meikle, 2003). In China alone, there was approximately 305 infected cases and 5 deaths while other countries, such as Singapore, Canada, and the U.S., began to report initial cases of patients with atypical pneumonia (Gittings & Meikle, 2003; World Health Organization, 2015). WHO officials instantly issued a travel advisory for all individuals to infected regions to prevent the further spread of the virus and remain cautious for possible symptoms that could develop during the incubation period (World Health Organization, 2003). Panic was rapidly escalating on the international front from health institutions and governments as the Chinese government faced increased scrutiny for their attempt to cover the scale of the outbreak (Gittings & Meikle, 2003).

By March 21, 2003, the CDC released the first preliminary clinical description of SARS describing the typical symptoms and characteristics of affected SARS patients. At the same time, health officials acknowledged that the severity of SARS and etiology of the disease remained unknown (WHO, 2003). This increased the emphasis on utilizing the international travel ban as a form of a global surveillance system. This was conducted through heightened screening of passengers traveling to and from infected areas and increased sanitization of aircrafts to prevent the international spread (Hoffmann, 2006). Meanwhile, entire teams of WHO health officials were traveling through the hospitals of Guangdong provinces to collect information on the patient population affected by SARS (World Health Organization, 2015). As shown in Figure 1, cases spread from the epicenter in Guangdong, China to countries from Hong Kong to Canada. By the end of April, the number of infected individuals from all 7 affected countries reached 3800 cases of which 200 were reported as deaths (WHO, 2015).

Figure 1.

Spread of SARS Cases by March 28, 2003 From the Epicenter in Guangdong, China.

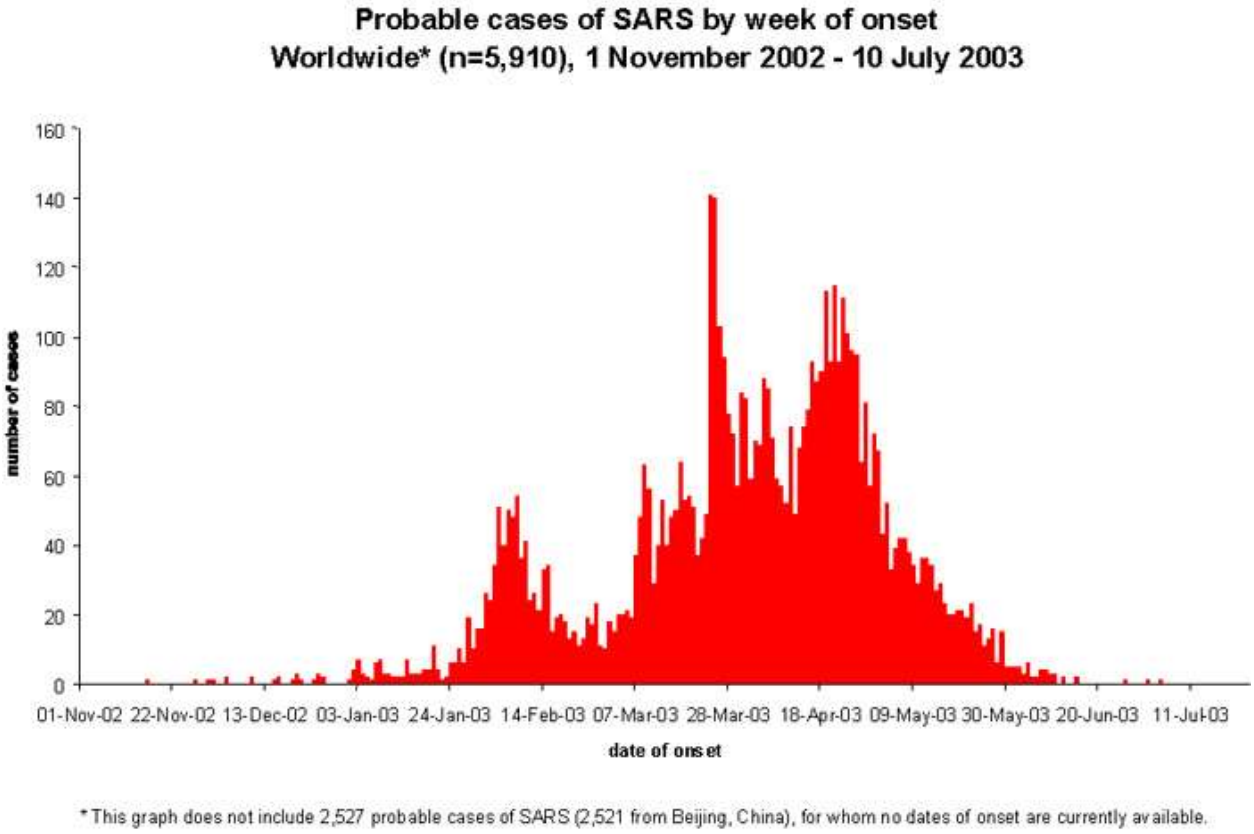


With the highest concentration of SARS patients being in China, which had a record high of 3000 cases, the government quickly imposed a set of precautions to begin to contain the epidemic. They shut down schools, public events, and other recreational events and issued a quarantine order for citizens (Hoffmann, 2006). Health officials were increasingly worried about the availability and capacity of medical resources in more rural parts of China as there were no real public health infrastructures in place to distribute medical resources and individuals.

The WHO began to lift travel restrictions in early July with Taiwan becoming the last country to be removed from the international list of possible local SARS transmission (World Health Organization, 2003). By late July 2003, the SARS outbreak was declared officially contained as the number of new cases reached zero, as shown in Figure 2 (Centers for Disease Control and Prevention, 2017). By the end of the SARS outbreak, the WHO had reported 8096 probable cases and 774 deaths (CDC, 2013). Epidemiological reviews concluded that the SARS epidemic could have been contained earlier if the proper public health measures had been put into place (Hoffmann, 2006). It was clear that all affected countries, especially China, should remain in continued vigilance and surveillance as the world was not completely SARS free (Thompson et al., 2003).

Figure 2.

Total Number of SARS Cases Reported Globally from November 1, 2002 to July 10, 2003.



China's Handling of SARS

From the beginning, the outbreak had slips in the surveillance net that gave SARS an easier route of transmission. This had severe health, political, and social repercussions not only in China but also on the international front. Local hospitals in the southern province of China had a weak chain of accountability and a lack of public health infrastructure in place to respond to a disease on the scale of SARS (Huang, 2004). The downplaying of the severity of SARS by Chinese physicians and government officials had severe impacts on the public.

The cracks in the political system were instantly noticeable as the old Chinese health minister and Beijing mayor were removed for failing to report the correct number of cases and claiming that the "crisis was under control" (Gittings & Meikle, 2003). The new health minister, Gao Quiang, gave a rare nationally televised public conference acknowledging the mishandling of the Chinese government through a weak epidemic control system (Gittings & Meikle, 2003). Mr. Gao stated that more than 200

SARS patients in military hospitals were undisclosed in the beginning and blamed the rapid spread and lack of preparedness in the Chinese public health system (Eckholm, 2003). Military hospitals failed to report the number of affected civilian patients that led to numerous errors and intentional deception (Eckholm, 2003). Domestic scrutiny increased as the public's faith in China reached an all-time low that many experts cite was comparable to the 1989 Tiananmen Square massacres (Eckholm, 2003). International scrutiny came from institutions like the WHO and CDC which questioned the balance between Chinese medical whistle-blowers and local individuals (Eckholm, 2003). While China was quick to correct its mistakes, the initial fragmented system only quickened the spread of SARS that could have been contained much earlier. This highlights the important relationship necessary between a proper epidemic response system and a chain of command with accountability.

Lessons Learned

The world learned several lessons after SARS that completely altered the field of global surveillance. It encouraged international public health institutions to establish early diagnostic tests, identify animal reservoirs, and create a global health database (Thompson et al., 2003). These three components would allow health officials to identify a virus much earlier and separate it from other similar cases. Additionally, identifying the origin increases the understanding of transmission methods that international scientific communities can use to prevent, diagnose, and treat affected patients.

It is important to keep in mind that no matter how robust a response system is, there is always a chance an entire country can succumb to a disease, as seen during the 2003 SARS epidemic. An explosive spread combined with no coordination among authorities or protocols for isolation methods between hospitals led to a disparity in infected patients and repercussions on a much bigger scale (Thompson et al., 2003). This distinct aspect of SARS separates it from its predecessors. An increase in governmental investment in infection control training for health and epidemiological specialists

could increase the awareness of not only the patients affected but also the physicians and nurses who are the ones responding first. These changes could have improved the flow of information between mainland China and the international community that would have been critical to controlling the spread of SARS.

One Health Approach

A One Health approach involves the use of human, animal, and environmental factors to approach a health issue (Stadtländer, 2015). This three-pronged, interdisciplinary approach allows for increased education between scientific communities, medical professionals, and the general public and could have been applied during the 2003 SARS outbreak as part of their epidemic response. A mutated virus at the center of any outbreak emerges not from a single factor but a combination of three factors, humans, animals, and the environment (Stadtländer, 2015). Identifying the source of the virus, or animal vector, in the triangle of One Health lends health experts a surplus of information as there is a small line between veterinary and human health (Stadtländer, 2015; Knobler, 2014). In the SARS epidemic, a civet was identified as the possible animal vector; however, a ban on exports was only enforced in January 2004, a year after the outbreak (Centers for Disease Control and Prevention, 2013). In addition, many small towns in southern China specialize in selling exotic animals for consumption as noted in the Karl Taro Greenfield's *China Syndrome.*

This aspect of the SARS disease has direct links to the human and environmental factors involved in the epidemic. Human health was instantly compromised as SARS began to spread in November 2002 (Centers for Disease Control and Prevention, 2013). Many infected patients were kept in close quarters with other patients experiencing similar respiratory illnesses that, when combined with the poor hospital infrastructure, led to dire mortality rates (Hung, 2003). Quarantine protocols were not in place which encouraged a lack of information and led to an explosive jump in the number

of infected individuals. Environmental factors involved poor sanitation that spread through fecal matter as SARS was known by spreading through any type of body liquid or air droplets that contained high concentrations of the virus (Hung, 2003). Housing estates, such as Amoy Gardens, were common in certain regions of China and allowed individuals to live in close proximity to each other (Hung, 2003). An infected individual experiencing diarrhea as a symptom of SARS could easily spread the disease through U-traps, the communal plumbing system found in these estates (Hung, 2003). This highlights how the interdisciplinary approach of One Health could have been targeted at any one of these situations.

Using a One Health approach definitely brings some barriers as it requires education, funding, and advanced diagnostics. The lack of these components in the Chinese public health infrastructure contributed to the rapid spread of the global epidemic (Stadtländer, 2015). Health professionals in medicine are trained to focus purely on human health without considering environmental or animal factors that can lead to overlooking certain aspects of disease treatment (Stadtländer, 2015). However, to better address health issues and more importantly, prepare us for the next epidemic similar to SARS, the disease must be viewed through an interdisciplinary lens between the human population, zoology, and the environment. One Health gives promise to developing new tools that better allow us to better predict and prevent a disease at the start of the outbreak rather than after.

Summary and Recommendations

The 2003 SARS epidemic affected approximately 8098 individuals, among which 774 died from November 2002 to March 2003. Through the combination of respiratory droplets and international travel, the virus quickly spread from Guangdong, China to as far as the United States. More importantly, the spread of SARS was facilitated by the gap in knowledge between the public, medical community, and public health officials in the Chinese government. This may have slowed the

dispersion of information to the international community but sped up the consequences of SARS on a health, political, and economic level. This epidemic has shed light on the importance of maintaining robust public health infrastructures that can respond quickly and effectively to outbreaks. Establishing a clear line of communication between physicians and nurses on the frontlines to the government and public health officials can help communities better follow proper health measures to mitigate the spread of a novel virus. Utilizing a One Health approach for the SARS outbreak could have provided a multidisciplinary approach to address the interactions between humans, animals, and the environment that are at the core of any outbreak. Utilizing this interdisciplinary lens not only allows public health officials to strengthen their response during an ongoing epidemic but also allows for the establishment of a strong framework to prevent the next epidemic.

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