

The SARS Crisis: Events and Future Prospects

**Thai D. Nguyen, Ph.D
Giang N. Trinh, D.Ph.**

(To NA - San Francisco, April 24, 2003/TDN)

- I - Introduction**
- II- The SARS Virus**
 - 1. Discovery and the SARS Sequence**
 - 2. Searching for SARS Origin and its hypothesis**
 - 2.1 Swapped Gene**
 - 2.2 Mutation**
 - 2.3 Bioterrorism**
 - 3. Transmission, Symptoms, Diagnosis and Treatment**
- III - In Search of a Cure**
 - 1. The SARS Vaccine**
 - 2. Drug Discovery**
- IV - The SARS Crisis in Vietnam and Dr. Carlo Urbani**
- V - Conclusion**

I Introduction

A form of flu known as serious acute respiratory syndrome, or SARS, has caught the medical and scientific community off guard. It has taken the breath of life away, both literally and figuratively, since the danger of the disease is unparalleled in the annals of health crises, including AIDS. As of April 24, 2003, SARS flu has killed more than 250 people and infected over 4,400 worldwide based on a recent WHO report, and the number keeps increasing linearly. The outbreak started in Guangdong Province, southern China, late last year (November 2002) before spreading to more than 22 countries in recent weeks. To make it worse, the fear of SARS has spread faster than the disease itself, and sent the economy and social activities of many parts of the world on a tailspin. The financial cost runs into hundreds of billions of dollars. Factor in public-health outreach efforts, quarantines, patient screening, and health education coupled with the impact this new disease has had on the retail, airline and tourist industries, and the final bill could be much more painful. If the disease continues to spread, quarantines could close factories and slow trade, affecting manufacturing--a sector which accounts for about 30% of Asia's gross domestic product (GDP). With the spread of the virus the effect could worsen and reach other robust economies of the world, including Europe and North America.

Interestingly, in terms of gravity, the SARS outbreak is tiny in comparison to the seasonal influenza which kills anywhere between 250,000 and 500,000 people every year around the world, or the "Spanish flu" pandemic of 1918 that killed nearly 50 million worldwide, or the "Hong Kong flu" pandemics of 1956-1957 and 1967-1968 that killed a combined 4.5 million people. The people's response might be an overreaction. "People clearly have reacted to it with a level of fear that is incommensurate with the size of the problem, and I think it is getting in the way of a reasonable response." said, Dr. David Baltimore, who won the 1975 Nobel Prize in medicine for his work on how viruses cause disease. Nevertheless, the SARS crisis keeps expanding. So the question is why could the SARS flu cause such enormous chaos and catastrophic effects on affected societies? The answer requires time and professional inter-disciplinary analyses spanning medicine, sociology, economics, psychology, etc. Nevertheless, the factors contributing to the devastating effects of SARS are obvious and include: (1) Its severity and mortality rate compared to ordinary flu. SARS has 3-4% mortality rate versus 1% for influenza. The most recent rate report for SARS was actually much higher, ranging 10-15% as of April 24, 2003. (2) Rapid transmission occurs via carriers and travels. In particular, healthcare practitioners are at high risk for the SARS virus (about 90% of the first 200 SARS cases in Singapore came from hospitals). (3) There is no cure for the disease, and most important of all is the mystery surrounding its etiology, its causation, and its lethality.

As the SARS crisis is quickly ravaging our lives and social structures, the information associated with the disease is expanding and changing rapidly on a daily basis. As of April 24, 2003, the incidence of SARS and its death toll was revealed to be 10 times higher in Beijing, and the virus has already shown signs of resistance to the current treatments in Hong Kong. Due to many unknown and controversial facts at present, it is not possible to write a comprehensive monograph on the SARS virus and its crisis. Here, we review events, analyze scientific information available, discuss future prospects of SARS to provide a summary of various snapshots of the disease's development. We hope the information will bring you an overview of the crisis, and we hope that it might also help us to deal with the SARS crisis in a controlled and positive manner.

II The SARS Virus

1 Discovery of the SARS Virus

In the battle against SARS, scientists have scored success in the identification of the agent of the deadly disease in record time. While it took 3 years to get similar results for the AIDS

virus, researchers nowadays spent roughly 3 months to identify the virus and 1 week to complete the sequence of the SARS virus's structure. This was possible mainly by the application of modern biology to isolate, clone and sequence the SARS virus. International collaboration has also played an important role leading to the speedy discovery. The World Health Organization (WHO) credits unprecedented international cooperation among the 13-member laboratory network established after the SARS epidemic began, for finding in record time the coronavirus, now known as the "SARS virus." The network includes laboratories from Hong Kong, China, Canada, France, Germany, Japan, the Netherlands, Singapore, the United Kingdom, and the United States.

In the experimental approach, the SARS virus was isolated from patients who met the case definition of SARS symptoms. First, cytopathological features of the virus were noted microscopically in cells inoculated with a throat-swab specimen. Electron-microscopical examination of cultures revealed ultrastructural features characteristic of SARS as coronaviruses. Immunohistochemical and immunofluorescence staining revealed reactivity with group 1 coronavirus polyclonal antibodies. The association of the SARS virus with the severe and acute flu was confirmed via application of the 4 rules of Koch criteria including (1) infection of the monkey with the SARS virus, (2) development of the flu in the monkey, (3) identification of the SARS virus in the monkey, and (4) recovery of the virus in cell cultures.


To clone the SARS virus, consensus coronavirus primers designed to amplify a fragment of the polymerase gene by reverse transcription-polymerase chain reaction (RT-PCR) were used to obtain a sequence that clearly identified the isolate as a unique coronavirus only distantly related to previously sequenced coronaviruses. With the specific RT-PCR primers several identical nucleotide sequences in 12 patients from several locations were identified, a finding consistent with a point source of the outbreak. These nucleotide sequences were then employed as probes to isolate the SARS viral genome of the patients for sequencing assays. This is a standard approach in cloning studies via application of the known sequence of a gene to isolate its homologs (or gene family members) of unknown sequences.

In the past week (since April 14, 2003), researchers from the Michael Smith Genome Sciences Center in Vancouver, Canada, became the first to complete the DNA sequencing of the SARS virus. The team includes nearly 30 scientists and has worked around the clock for a week. In the US, the Centers for Disease Control and Prevention (CDC) has also spearheaded the studies and sequenced the viral genome for SARS. In both studies by the Canadian and US researchers, the genome of the SARS virus is 29,727 nucleotides in length, with 10 bases different by the two groups. In addition, scientists at the Centers for Disease Control in Atlanta, meanwhile, used a sample from a SARS victim in Hanoi, Vietnam, to complete their genetic sequencing and have produced almost identical results. The virus is also named "Urbani SARS-associated coronavirus" in memory of Dr. Carlo Urbina of WHO office in Hanoi, who first alerted the medical community about the SARS virus and also became a SARS victim (see more in Section IV). Later, Malik Peiris and his team discovered the SARS virus at Hong Kong University, and for simplicity's sake, the researchers who reported the virus sequence named it "SARS virus".

The SARS sequence confirmed its similarity to coronaviruses that was suggested from the microscopic observation. As a general feature, the coronaviruses have a single-stranded, positive-sense RNA genome that is divided into seven genes; its virions consist of four to five structural proteins. The coronaviruses vary in virulence, organotropism and cell tropism, and are constantly evolving by naturally occurring mutation and recombination. The coronaviruses are responsible for about 30% of seasonal flu; influenza and rhinoviruses are the other two major pathological agents of the seasonal flu.

While the SARS virus shares its structure with the coronaviruses, the proteins that make up its content are quite different, making it a brand new virus. While in some regions of its genome, the SARS virus is more than 75% identical to known animal and human coronaviruses, it diverges widely in others. To deduce its probable gene structures, the genome of SARS sequence are compared to all other known coronaviruses that have been sequenced like corona

viruses of pigs, bovines, chickens and humans. So far, the genes deduced from the SARS virus genome corresponding to the predicted polymerase protein (polymerase 1a, 1b), spike protein (S), small membrane protein (E), membrane protein (M), nucleocapsid protein (N) and other genes possibly from novel sequences have been identified. In brief, the virus has the spike protein S for invasion of the host cells (the spike protein forms the crown shape of the virus thus named coronavirus); the polymerase to manufacture multiple copies of itself inside the cell; other proteins are investigated. In summary, vigorous research to decipher the genome of SARS is being conducted by modern biology laboratories worldwide to identify the genes and their mutations that have caused the lethal consequences seen in the current SARS crisis.

The sequence of the SARS virus could be obtained from the following file: [Entire Nucleotide Sequence of SARS-CoV \(Urbani strain\)](#)  PDF. The features of SARS including its core RNA, granular viral cap and spike protein coat are shown below.



Proposed structure of SARS virus (also known as Urbani SARS-associated coronavirus). The virus is characterized by its spike proteins of crown shape.

2 Searching for SARS Origin

An immediate challenge for SARS researchers is to identify the origin of the virus. Such information is critical for understanding the initial transmission of the disease, which could help to break the transmission chain. The information could also have important implications for understanding the nature of SARS. Like other cold flu viruses including coronavirus, influenza, rhinovirus, the SARS virus is expected to have its origin from animals. The parallels of SARS with flu viruses are obvious. Both are respiratory diseases, highly infectious and both, apparently, have jumped from animals to people. It is now suspected that like coronavirus, SARS begins as an infection of birds, one that does not make its avian hosts ill. A slight mutation allows the virus to move into people, sometimes via an intermediate host such as pigs. Once a person got infected, he could initiate a chain of transmission of the virus to others. China appears to have a very high probability of developing several recent flu epidemics including SARS; the country has the world's largest population, and also has very large numbers of aquatic birds and pigs. The animals have close contact with people allowing the jump of flu viruses from animals to people. It is now critical to identify the birds or animals from which the SARS virus has evolved. To do so, scientists are gathering samples and screening for SARS virus from animals in Guangdong Province, China, where the disease probably arose.

SARS researchers have offered several explanations for the phylogeny of the SARS virus. In this effort, the established sequence of the SARS virus is providing important tools to look at different possibilities. Below are hypotheses on where and how SARS genome could evolve.

2.1 Swapped gene hypothesis: The SARS coronavirus might have arisen when animal and human viruses met and swapped genes. In this theory, an animal virus underwent "recombination" (an exchange of genetic material) with other coronaviruses, allowing it to infect humans and cause disease.

Supporting this theory is the fact that coronaviruses are unusual in their ability to reshuffle genes easily, explains Michael Lai of the University of Southern California in Los Angeles, who works on coronaviruses. The study shows that the viruses "can easily switch their host range by

switching genes", he says. Another team created the new coronavirus by injecting cat cells with feline infectious peritonitis virus (FIPV), a common pathogen that kills around 5% of cats. The researchers added a gene fragment from a mouse coronavirus; this makes a coat protein that recognizes and helps to penetrate mouse cells. After several hours, some particles of the cat virus had exchanged their coat gene for the mouse one, and could then infect mouse cells. This is analogous to what might happen if the two viruses simultaneously infected the same cell.

This attractive working hypothesis, that the new SARS virus formed when two coronavirus strains met in an animal and swapped genes, now seems less likely. Sequence analysis suggests that the SARS virus contains no evidence to support recombination events proposed in the swapped gene model. This is agreed by both coronavirus experts including Dr. Michael Lai and Dr. Rob Holt, Head of Sequencing at the Genome Sciences Center, Canada.

2.2 Mutation hypothesis: SARS is most likely a coronavirus that could have undergone some mutations and changed its genetic makeup to become a SARS virus, the experts now hypothesize. In this hypothesis, an unknown human coronavirus that circulated among animals and then mutated rapidly after infecting a human. Or an animal coronavirus could have mutated before jumping to humans as in the case of other flu viruses. Whatever the possibilities, mutation studies is a crucial step to identify the genes and their roles in the virulence of SARS. Likewise, it is of major interest to understand what causes the mutations. Information on the environment versus genetics influencing the mutations could provide valuable knowledge on the evolution of the SARS virus from its ancestral coronaviruses.

The possibility of constant mutation of the SARS virus in human cells could be critical for understanding the nature of the virus and its role in SARS etiology. The increased severity associated with diarrhea found among 300 residents of the Amoy Garden apartment complex in Hong Kong supports the idea of an altered tissue preference; this means the SARS viral strain that attacks the lungs could mutate to attack the gut, and other tissues such as kidneys, as recently reported. This tissue switch mirrors effects seen in several animal coronaviruses. A bovine gut coronavirus, with some genetic sequences similar to the SARS virus, can also cause severe pneumonia in cattle. The switches were shown to involve mutations in the viral gene coding for the spike proteins. Luis Enjuanes and colleagues at Spain's National Center for Biotechnology in Madrid have switched the pig coronavirus from a mild respiratory infection to a virulent gut infection solely by mutating the spike protein gene. Based on this suggestion, scientists are likely to look for changes to the spike protein gene in the SARS virus infecting Amoy Garden patients and other similar cases.

In fact, recent sequencing studies of various groups seem to support the idea that the SARS virus is expected to mutate very fast and easily. There are 15 nucleotide sequence variants found in the nearly 30,000 nucleotides that comprise the virus, when these sequences are compared. Although errors in the sequencing process would be possible, the mutations appeared to be authentic. This is suggested from the evidence that most of the 15 variations associate with one gene in particular, while 12 more genes show no changes. The sequence variants were discovered by scientists at the Beijing Genomics Institute and the Institute of Microbiology and Epidemiology of the Academy of Military Medical Sciences, and posted on the Internet recently (April 26, 2003). With more sequencing available from other sources, the mutagenized nature of SARS will soon be confirmed. If so, this will add another chilling fact to the crisis caused by this mysterious killer virus.

2.3 Bioterrorism hypothesis: Nikolai Filatov, Head of Infectious Disease Center, Moscow had a different thought on the existence of SARS. He believes the SARS virus might be a product of bacterio-terrorism research, which was created via application of gene cloning and accidentally escaped from the laboratory environment to the public. He suspected SARS as a recombination of coronavirus with other potent virulent viruses such as mump and measles. The recombination could only be achieved via cloning, and not be possible from natural mutation, he argued. The concept was also based on a number of criteria that SARS appears to match those for germ warfare production such as unusual genetic makeup, contagious nature, and a

population not immune to it. For our safety and hope for a cure, we certainly do not want to see that this is the case. Rapid progress in SARS research should soon verify this suspicion on the origin of SARS.

3 Transmission, Symptoms, Diagnosis and Treatment

The SARS virus is contagious and more stable than previously anticipated. The virus can last up to 24 hours outside our body as compared to the average of 5 hours for other flu viruses, making the working environment a serious risk of SARS transmission. Direct and repetitive contacts are a major cause of transmission of the SARS virus. Of major concern is the fact that 90% of the first 200 SARS affected individuals in Singapore belongs to health care practitioners, and many doctors and nurses became SARS patients in other parts of the world. SARS therefore damages the infrastructure of the healthcare system, making its effects more devastating for public health with respect to prevention and treatment.

The virus is believed to spread in symptomatic, but not in non-symptomatic, carriers. Droplets from affected individuals, via coughing and handshake, are likely important vehicles of the transmission. Facemasks could help to reduce or prevent the propagation of the droplets. N95 type masks are recommended by CDC. Facemasks, however, do not prevent the virus transmission when it is airborne. Hand washing could be an important practice for inhibiting SARS transmission. The spread of SARS has been lesser in Japan, possibly due to frequent hand washing among the Japanese. The incidence from the Amoy Garden apartment complex raised a red flag about another type of transmission of the SARS virus, possibly via patient excrements such as feces. The sewage system has then become a major concern as the virus could be airborne into open sewers and migrated from toilets to showers and kitchens. Apartments in Singapore are constructed with closed plumbing systems, therefore contamination through drainage is significantly reduced. This might explain the slow transmission rate of SARS among apartments in Singapore as compared to Hong Kong.

Symptomatically, the disease has been characterized by rapid onset of high fever (over 100 degrees) , myalgia, chills, rigor, and sore throat, followed by shortness of breath, cough, and radiographic evidence of pneumonia. The incubation period has generally been 3-5 days (ranging from 2-7 days). The quarantine time is, therefore, 10 days for people suspected of SARS. Early detection and treatment offer a better chance for recovery. The thermal screening device is a useful tool to identify travelers at risk for SARS. Based on the virus sequence, RT-PCR is a specific diagnosis for SARS; antibody test is not yet available. Treatments include Ribivarin, an anti-viral used to treat hepatitis C virus, and steroids to calm down the immune system. The treatment is not a cure, but it helps to relieve the patients' symptoms and to keep the body fighting for survival. Most victims of SARS are shown to have been affected by aging or other illnesses, but this fact might change as the virus evolves from its invasion process.

III In Search of a Cure

Due to the worldwide spread of SARS and the urgency for an immediate treatment, top medical authorities are under pressure to consider all possible curative options. Time is of the essence in this case. Here we discuss two major trends, the vaccine and the drug screening approach that will be the focus of the medical research community as well as the pharmaceutical industry in their struggle to achieve treatments and cure for SARS.

1 The SARS Vaccine

In a recent meeting, the U.S. Centers for Disease Control (CDC), and the National Institutes of Health (NIH) issued a call for cooperation among research centers and the pharmaceutical industry. Now that the virus has been identified, the government made it clear that it wants to talk to anyone who can make a vaccine to dampen the SARS epidemic. Attendees at the meeting included major U.S. vaccine makers Merck Inc., Wyeth, Chiron Corp., Vical Inc., Avant, Glaxo Smith Kline, Aventis, Powder Ject Pharmaceuticals, Berna Biotech, Johnson & Johnson and Baxter International Inc. As for the time required, the chief executive of Vical, Vijay Samant, predicted it would take at least two years for a SARS vaccine to be

developed and moved into clinical trials. Dr. Skidmore of Merck cautioned it could take additional years for a safe and effective vaccine to emerge. The researcher noted that Merck is still striving after a decade of work to develop a vaccine against HIV, the virus that causes AIDS.

The quickest possible vaccine approach was considered. The procedure includes growing the virus, killing it and then delivering it by injection to spur protective antibodies against future infection by the live virus. Because SARS is an unusually virulent species, the procedure requires a high-security facility for the experiments, and the vaccine might take up to 2 years from development to clinical trials, according to Vijay Samant, chief executive of Vical..

Others favor developing a potentially more effective and safer oral vaccine containing key proteins from the surface of the SARS virus, called antigens, that have been loaded into live but genetically disabled cholera bacteria. Identification of the antigens is the key step and could take several years of biological studies and clinical investigation to accomplish.

Advances in the application of genetic techniques and immunology have led to a speedy development of experimental vaccines against emerging viruses. An encouraging news item is the recent achievements of a flu vaccine for the influenza virus H5N1 by researchers of St. Jude Children's Research Hospital in Memphis, Tennessee. Their approach is based on modification of viral genes to abolish their ability to cause disease but still maintain their antigenic properties, and therefore made the vaccine safer to use. The procedure is known as "reverse genetic" vaccine since it involves changing the genes and expressing them in the cells for antibody synthesis.

In the case of the vaccine for H5N1 influenza, the viral genes produce proteins called HA, and NA, which are on the surface of the virus, in full exposure to the immune system. The researchers modified the HA and NA genes and mixed them inside a cell with six genes from another virus, H1N1. Because of the alterations to the HA and NA genes and the rest of the genes being derived from H1N1, the new virus cannot cause disease. Rather, it can only stimulate the immune system to respond to H5N1. "The vaccine looks deadly enough for its HA and NA proteins to alert the immune system. But in reality, the vaccine is like a gun without ammunition and can't cause disease." said Elaine Tuomanen, director of the St. Jude Department of Infectious Diseases.

The reverse genetic technique certainly does speed up the process of developing vaccine strains and SARS researchers attempting to extend the method to other viral diseases. The National Institute of Allergy and Infectious Disease announced recently that it had begun working on a SARS vaccine, but director Anthony Fauci warned the effort would take at least a year or more. The reason is our limited knowledge about SARS, particularly on the genome of its suspected antigens, which is far too big compared to the H5N1 influenza virus.

Whatever the approach for the vaccine, safety must be of primary importance in the case of SARS as the global population is ready to take the vaccine as soon as it is available.

2 Drug Discovery

Along with vaccine research, scientists working in drug discovery urgently plan their strategies to meet the challenge of SARS. They are considering a "shot-in-the-dark" approach with the hope of bringing about a quick discovery of drugs that could have therapeutic effects on SARS illness. Among these are testing medicines already on the market. The breakthrough a week ago in decoding the SARS virus's genetic makeup should give scientists some logical targets for such tests. While Ribavirin is commonly prescribed for SARS treatment, it was recently shown to be ineffective against the SARS virus growing in tissue cultures. The study was performed by the U.S. Army Medical Research Institute for Infectious Diseases at Fort Detrick, Maryland. However, some experts think it may be too soon to discount Ribavirin. Dr. Michael Lai, a coronavirus expert at the University of Southern California, suggests that if it does not attack the SARS virus directly, the drug might somehow bolster immune defenses, therefore is useful for the treatment.

Researchers are now testing other antiviral drugs on the market. They include 16 AIDS drugs, 13 herpes drugs and 7 drugs aimed at flu and other viruses. Also to be tested are 7 types of interferon, which are the body's natural viral killers. Just as importantly, researchers are focusing on about 30 drugs not yet approved but already in testing for viral processes similar to those in the coronavirus. Therefore, they offer a better chance of getting a candidate drug for SARS. Some of these drugs may act on the cell surface to prevent the virus entry inside the cell, or inhibit the replication of the virus to minimize its copy number.

For the long term, a more defined and systematic approach is planned for drug discovery for SARS. Armed with the genome established for the virus, researchers can employ genomic science technology in the search for a cure. Since the development of Human Genome research, the drug target gene approach has become a standard procedure for drug discovery and research in the pharmaceutical industry. Briefly, the procedure includes target gene identification and target gene validation. Accordingly, structural and functional analyses of SARS genome are required to identify pathogenic genes of the virus. The genes are then validated for their responses to candidate drugs. Proteomic research to characterize protein structures, bio-informatic applications, pharmacogenomic work to define biological and pharmaceutical properties, and high throughput screening of large compounds are new principles of drug target gene research. The drug target gene approach offers specificity for the treatment, besides reducing time and cost of the discovery compared to the conventional drug research in the past. Nevertheless, the procedure still requires five years or more, which is the minimum time most experts say is needed to develop a drug from scratch, such as in the case of SARS. To leave no stone unturned, researchers and medical practitioners are also tapping into other resources such as herbal medicines to increase the odds of prevailing over the SARS virus.

In summary, unlike the rapid success achieved for the SARS genome sequences, the search for a cure faces a major hurdle, and is expected to be much more challenging. Two scenarios are anticipated for future SARS treatments. First, the urgent approach of weakening the virus for making vaccine or screening candidate antiviral drugs might result in a fortunate outcome. Secondly, the conventional approach, which is more systematic and time-consuming, would offer specific and safe therapeutic agents for the disease.

There are hopes and there are uncertainties. There is a lot of work ahead that requires the talent and dedication of medical researchers as well as authorities to make our quest for SARS treatments a success. More importantly, it must also come soon.

IV The SARS Crisis in Vietnam and Dr. Carlo Urbani

Vietnam is one of the first countries hit by SARS. While the nature of the disease is similar to those in other parts of the world, there are a number of facts about the epidemic in Vietnam that are meaningful for the history as well as the learning experience about the disease.

It began with an infected Chinese-American man who arrived in Hanoi from Hong Kong in late February this year on a business trip. When he fell ill, the businessman was treated in Hanoi's Viet-French hospital, infecting scores of doctors and nurses, before being evacuated to Hong Kong, where he eventually died. In contrast to China, where very little was revealed about SARS, while the illness remained unknown, Vietnam's medical establishment has rapidly responded to the urgency of the disease. The patients were isolated and the medical personnel, and the public were fully informed about the potential danger of the mysterious illness. The effective response to SARS in Vietnam is credited in a major way to Dr. Carlo Urbani, a WHO member from Italy, who first recognized the unusual and severe nature of SARS. He alarmed the medical staff in Vietnam as well as the medical community of the world about SARS. Regrettably, his knowledge of SARS came with a great price, which is his life. He was very close with the patients of the mysterious flu and has become one of them. He passed away at the age of 46.

Dr. Urbani name was proposed by WHO for the SARS virus as he was considered the Paul Revere of the SARS crisis (Paul Revere, an American patriot who risked his life to alarm his troops about the coming of the British soldiers during the American revolution for independence

from Britain). We have a profound admiration for Dr. Urbani and his sacrifice while caring for the SARS patients in Vietnam, and applaud the recognition by WHO of the service of Dr. Urbani for the cause of SARS. In addition, we would like to acknowledge here other doctors who have also sacrificed their lives while sharing the service with Dr. Urbani for the SARS patients in the Viet-French Hospital in Hanoi. This includes Dr. Jean Paul Derossier of France and Dr. Phuong Nguyen of Vietnam.



Dr. Carlo Urbani, regarded as the Paul Revere of the SARS crisis while serving in Vietnam.

As of May 1, 2003, there are 63 reported SARS cases in Vietnam, 5 deaths and 56 recoveries. The cases are only restricted to the two regions of Hanoi and Ninh Binh, both in North Vietnam. There were no new suspected cases reported for SARS since early April. This is an unusually good record considering the rapid expansion of SARS in other parts such as Hong Kong, China, Canada, Singapore, etc. The accomplishment received acclaim from WHO as a hope for a possibility to control the spread of SARS. "In Vietnam, certainly, the disease has been brought under control...We have not had any new cases for over 10 days," said Dr Julie Hall, coordinator for the WHO's global outbreak alert and response unit.

It appears that emotion runs very high in the SARS crisis. The slowdown of SARS incidence in Vietnam gave certain people the impression that the threat of SARS is blown out of proportion, and they anticipate the epidemic would soon be contained. We all hope that this would be the case, and only time will tell. In any situation, this will not come naturally, but commitments and responsibilities are essential. "The illness could return to Vietnam if tough quarantine measures are not imposed at airports and along the borders" said, Dr. Le Dang Ha, director of the Tropical Diseases Institute of Hanoi's Bach Mai hospital. Indeed, Vietnam has taken very strict measures to counter the spread of SARS since it was first discovered in February. In an attempt to control the disease, the country has applied tight quarantine inspections at international border gates and airports to prevent the spread of the SARS virus. Foreign travelers are required to fill out forms detailing their medical status. All travelers, particularly those coming from SARS-hit countries and regions, are subject to medical observation.

A natural concern is how long the quarantine measures could hold up under the pressure of thousands of visitors and business partners coming to the country daily by air, land and sea. There are also concerns whether the rural areas in Vietnam, with financial hardship and where the majority of the population is, could challenge SARS via quarantine alone. Vietnam has the basic DNA technology to detect SARS virus such as RT-PCR; therefore suspected individuals could be identified at an early stage of the infection. Much more modern sciences are needed to be developed in Vietnam to strengthen the safeguard against SARS as well as other medical issues for the people. SARS also brings people of the region closer together. East Asian countries recently met in Malaysia to come up with a joint plan to fight SARS. This will lead to more collaborations among researchers and clinicians, and more sharing of laboratory and clinical experiences on the SARS crisis, which eventually would enhance protection for the region's people including Vietnam.

V Conclusion

The SARS crisis is an urgent challenge with global effects. International authorities and the scientific community are taking immediate measures to meet the challenge. Modern biology has taken the pivotal lead in the fight against SARS. The identification of the SARS virus and the establishment of the genome sequence of SARS within a short time are an important initial step. However, this is only the tip of the iceberg of the SARS crisis in terms of understanding its biology and making discoveries for treatments. While recent advancements in biological sciences are providing researchers with needed knowledge and tools to deal with the more crucial issues of the virus, including its structure, functions that constitute the etiology of the disease, we should not forget that AIDS remains an unsolved problem after more than 20 years. The researchers are also clear about applying their knowledge to the making of vaccines as well as discoveries of drugs for SARS treatment. We should, however, keep in mind that a vaccine for AIDS, which was expected within 5 years of its discovery, is still in the making!

The prolonged AIDS fight has shown us how limited our application of scientific knowledge could be, and the current SARS crisis once again shows how vulnerable we all are to the eruption of a medical problem such as the SARS virus. However, there is a great hope as the medical communities worldwide are fully alert and very determined in their fight against SARS. Our best hope is that the SARS spread would be contained with strict application of quarantine measures, as seen for certain flu events in the past. However, if we have to engage in this fight, we must win. We have seen that technological advance could bring a swift victory in the Iraq war; there should now be a more compelling reason for nations to commit their resources and apply their sciences to the battle against SARS. There is no better cause for science than serving the well-being of mankind, particularly in a crisis which severely affects our lives like SARS.

Note: *Due to rapid changes in the SARS crisis, many of the events mentioned in this writing have not been published at the time. Therefore the reference section is left out. Instead, we include names of persons in charge, and organizations when possible.*

Acknowledgement: *The authors wish to thank Thomas D. Le, Ph.D. for his assistance in reviewing and editing this article.*