Part I

Assessment Cases: Overview

Assessment is the foundation of public health. Before decisions can be made, before policies can be determined, before programs can be planned, public health professionals must assess the situation at hand. Two of the 10 essential public health services fall into the category of assessment:

- Monitoring health status to identify community health problems.
- Diagnosing and investigating health problems and health hazards in the community.

Additionally, as with all of the services categories, research is an integral component. Thus, assessment also includes the 10th essential public health service: research for new insights and innovative solutions to health problems.

The assessment section includes four case studies that can be used to examine issues related to assessing health status and community health problems. The cases are:

1. The Toronto Severe Acute Respiratory Syndrome II Experience
2. A Feasibility Study of Routine Screening for HIV in an Urban Emergency Department
3. Male Circumcision and HIV: An Evidence-Based Public Health Approach
4. Research Synthesis: Systematic Review and Meta-Analysis of Vioxx and Cardiovascular Events

In March of 2003, the World Health Organization (WHO) declared a global health alert for severe acute respiratory syndrome (SARS). An acute respiratory illness, SARS was first mistaken for atypical pneumonia when patients presented to hospitals in Hong Kong and China. The case study, *Toronto Severe Acute Respiratory Syndrome II Experience*, takes place after SARS was identified as a new and deadly illness and presents the events as they unfolded in Canada after the first reported infections and deaths occurred in other countries.

The Toronto case examines how public health officials in the Ontario province of Canada grappled with the challenges of detecting and diagnosing a new disease, SARS, in 2003. As WHO and countries affected by SARS reacted and responded to the transmission of the disease, people were advised against traveling to infected regions, including Toronto. Over the course of 10 weeks in 2003, Toronto moved back and forth on worldwide travel advisories. This case considers lessons Toronto might have learned between its first outbreak and the second wave of cases that hit the city.

At the core of the Toronto SARS II case, as with the others in this section, is the use of epidemiology as an analytical process used to assess infection, risk, and response. All of the cases in this section can be used to help learners better understand what epidemiologic measures are relevant, depending on the circumstances at hand. Learners will also have opportunities to practice calculations and to use the results to make recommendations for next steps.

Two cases in this section address the human immunodeficiency virus (HIV), but in very different circumstances. *A Feasibility Study of Routine Screening for HIV in an Urban Emergency Department* examines whether to institute a routine screening program for HIV in a Washington, DC, hospital. The District's AIDS incidence rate was higher than any other major metropolitan area in the United States in 2006. Further, national estimates indicated more than 1 million U.S. residents were infected with the human immunodeficiency virus, and approximately one-quarter of these individuals were unaware they were infected.[1]

In order to assess whether to begin a routine screening program, public health experts needed to consider who would be screened, estimate how many people would need to be screened, and estimate how many people screened would need counseling or other support. The concepts of prevalence, predictive value positive and predictive value negative are considered, along with exercises to calculate each. The case also pays close attention to the ethical and logistical issues a screening program would create for the hospital, health providers, patients, and the public health in general if executed.

Male Circumcision and HIV: An Evidence-Based Public Health Approach considers HIV from the perspective of public health experts making recommendations to countries around the world as they determine whether and how to create male circumcision interventions as a mechanism to decrease the transmission of HIV. The case begins by putting learners in the shoes of experts tasked with defining the problem and assessing the evidence for efficacy as to whether male circumcision works under the conditions in which it had been studied.

Again, epidemiologic methods lie at the heart of the case. Students are asked to assess evidence from randomized clinical trials on male circumcision as an intervention. The case study steps through the process by which such an analysis might be undertaken. Concepts such as relative risk, attributable risk percentage, and transmission rate are covered along with exercises to calculate each.

Both of the HIV cases address not just the analytical methods used to determine epidemiologic results, but also how to use this information in real-world circumstances. Data calculated in the abstract can be difficult to apply in populations involving actual human beings in complex societal settings! Sensitivity to cultural issues, the need for transparent and continued communication, and health systems issues are all key components of these cases.

To close the assessment section, *Research Synthesis: Systematic Review and Meta-Analysis of Vioxx and Cardiovascular Events* presents students with basic information on how to review, assess, and evaluate studies in order to summarize and interpret epidemiologic evidence on human health effects. The case explains the procedures used for conducting systematic reviews and meta-analyses.

After students become familiar with the methods, the case presents information from two systematic reviews and meta-analyses published by scientists scrutinizing adverse cardiovascular outcomes among patients using the drug rofecoxib (Vioxx®). Learners are encouraged to assess data and to interpret and draw conclusions about the information presented to them from the two published meta-analyses.

Assessment is the first step in a cycle of activities to support the public's health. The collected cases emphasize the use of evidence to drive solutions and policies. Just as importantly, these cases help provide key insights from real-world examples that move from the theoretical to the practical when deriving public health solutions.

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CASE 1

The Toronto Severe Acute Respiratory Syndrome II Experience

LARISSA MAY AND RICHARD SCHABAS

> "SARS I was not avoidable. We were struck by lightning. Everything after that was [avoidable]."
> —Dr. Richard Schabas, chief of staff, York Central Hospital

INTRODUCTION: SEVERE ACUTE RESPIRATORY SYNDROME II IN TORONTO: AN AVOIDABLE EPIDEMIC?[i]

In late April 2003, Toronto began to take a collective sigh of relief as severe acute respiratory syndrome (SARS) faded away. Toronto had been one of a handful of cities hit by SARS and the only one outside of East Asia. The hospital and public health sectors had operated in crisis mode since March. There had been a total of 140 probable SARS cases, 178 suspect cases, and 24 deaths in a metropolitan area of 4.5 million people.[1]

A provincial emergency had been declared on March 26. In an effort to decrease SARS transmission, strict infection control measures had been imposed on all area hospitals, and two hospitals had been shut down entirely to new admissions. About 20,000 people, possibly exposed to SARS, had been told to go into voluntary quarantine for 10 days.[1]

On April 23, the World Health Organization (WHO) had issued a travel advisory about Toronto—recommending against nonessential travel.[2] Toronto was the focus of unwelcome global media attention. The city's reputation and its economy were suffering. The entire population was on edge.

And then SARS was gone, almost as suddenly as it had arrived. Public health authorities announced that there had been no new cases of SARS for 20 days—two full incubation periods. A delegation of dignitaries led by the provincial minister of health, an elected politician, had gone to WHO's headquarters in Geneva to plead Toronto's case that travelers were never at risk and the outbreak was over in any case. WHO officials seemed to be receptive to Toronto's message. On April 29, WHO lifted its Toronto travel advisory on the assumption that the SARS outbreak there was over.[3]

Cautious optimism began to replace the pervasive sense of gloom in Toronto.

However, Dr. Bill Osler, chief of staff at the North Toronto General Hospital (NTGH) was not so sanguine. He was aware of some troubling cases of pneumonia among staff and patients at NTGH over the course of a few weeks. None of these cases met the definition of SARS (see Box 1-1) because none of the staff or patients had direct contact with SARS patients.

Dr. Osler knew that pneumonia was not a rare disease, especially among hospitalized patients. SARS pneumonia is clinically and radiologically indistinguishable from pneumonia caused by dozens of other bacteria and viruses. Serologic tests for antibodies to the novel coronavirus that causes SARS were in their infancy and were still unreliable. There was no diagnostic test for SARS.

Dr. Osler was still concerned. NTGH did care for some SARS patients, although this was in a special isolation unit. Three of the five patients with hospital-acquired pneumo-

[i] This case study is based on the SARS II outbreak in Toronto in April to May 2003. However, many of the facts have been altered and the persons portrayed are fictional and not meant to represent any real persons.

BOX 1-1 Case Definitions for Surveillance of Severe Acute Respiratory Syndrome (SARS), May 2003

A *suspect* SARS case is one involving a person with fever and respiratory symptoms and a history (within 10 days) of close contact with a SARS victim or travel to or residence in an area with recent SARS transmission.

A *probable* SARS case is a *suspect* case with X-ray evidence of pneumonia and no alternative diagnosis that explains the illness.

Source: Based on WHO case definition.

nia were from the psychiatric ward—not a typical high-risk group. An NTGH nurse admitted to another hospital with a diagnosis of pneumonia did have direct exposure to an elderly orthopedic patient with hospital-acquired pneumonia. Typical hospital-acquired pneumonia is not contagious.

Dr. Osler shared his concerns on the biweekly teleconference of Toronto area hospitals and with public health officials. No one seemed interested. "SARS is over," was the attitude. Time to move on.

In early May, Dr. Osler and NTGH faced a crucial decision. Toronto was approaching 30 days—three maximum incubation periods—without a new reported case of SARS. Ontario and Toronto public health authorities were preparing to declare the outbreak over. This had already happened with the SARS outbreaks in Hanoi and Singapore. WHO had lifted Toronto's travel advisory.

More directly relevant to NTGH, the Ontario Ministry of Health announced that the strict infection control protocols—routine screening of staff, patients, and visitors; gowns, gloves, and respirator masks for all staff all of the time—imposed in March would be lifted on May 6. SARS was gone, the logic ran, so these precautions were no longer necessary.

However, Dr. Osler received some disquieting information. Several patients who had recently been discharged from the orthopedic ward at NTGH had developed pneumonia while at a nearby convalescent hospital. Postoperative pneumonia in elderly patients is not uncommon. Still, Dr. Osler was concerned that NTGH had seen more than its share in the previous few weeks. The weight of circumstantial evidence was mounting that something unusual was afoot. Was this just a run of bad luck or could this have been SARS?

Dr. Osler was also aware of a commentary in the most recent edition of the *Canadian Medical Association Journal* (CMAJ) warning that Toronto hospitals needed to continue strict isolation procedures (see Box 1-2) for SARS.[4]

There would be substantial consequences—for NTGH, for the Toronto healthcare institutions, for public health, and for the provincial government—if this was declared a possible SARS outbreak. On the other hand, lifting the infection control measures and allowing SARS to spread unhindered would be too terrible to contemplate.

Dr. Osler looked back . . .

LIGHTNING STRIKES—SARS I

In November 2002, new cases of atypical pneumonia (subsequently determined to be caused by a novel coronavirus) began to appear in Guangdong Province in China.[5,6] Because atypical pneumonia is not unusual (the *atypical* refers to the causative organism and not any usual presentation) and the cases did not appear related, these early SARS cases were not recognized as a new disease.[7] On February 14, 2003, the World Health Organization reported more than 300 cases of atypical pneumonia in Guangdong, along with 5 deaths, since November 2002. Of particular concern was that more than 30% of cases occurred in healthcare workers—a very unusual pattern.

There was controversy about the causative agent. The Ministry of Health of China initially declared the illnesses

BOX 1-2 The Difference between Quarantine and Case Isolation

Quarantine is the mandatory or voluntary separation of healthy people thought to have been exposed to a communicable disease and who may be incubating the infection from those who have not been exposed.

Case isolation is the isolation of people thought to be actually ill with the communicable disease.

Quarantine targets the incubation period while case isolation targets the period of clinical illness.

were caused by *Chlamydia pneumoniae*—a common cause of atypical pneumonia. However, ProMED-mail, a global electronic reporting system for outbreaks of emerging infectious diseases, alerted its electronic mailing list subscribers that based on lack of autopsy confirmation, the illnesses might not be caused by *Chlamydia*.[1,8]

A physician from Guangdong, who had treated some of the cases of atypical pneumonia, arrived in Hong Kong to attend a family member's wedding and stayed at the Metropole Hotel on February 21.[1] Displaying signs of an illness that was later determined to be a new disease, termed severe acute respiratory syndrome (SARS), he subsequently infected at least a dozen hotel guests and travelers from several countries. On February 23, Mrs. K returned to Toronto from Hong Kong after a 10-day stay where she had been unknowingly exposed to the infected Chinese doctor. On her return home, she fell ill. After several days of fever, muscle aches, and a cough, Mrs. K died at home on March 5, 2003. No autopsy was performed, and her cause of death was attributed to a cardiac arrest.

On March 7, Mrs. K's son, Mr. T, who had not traveled to Hong Kong, became ill with a fever, cough, and worsening shortness of breath. He presented with these symptoms to Scarborough Grace Hospital's Emergency Department. Due to hospital overcrowding, he waited more than 18 hours in the emergency department for inpatient admission. During his emergency department stay, he received nebulized[ii,8] medications and had contact with many staff, patients, and outside visitors. Upon admission to a hospital ward, however, he was isolated due to concerns about tuberculosis. A public health investigation and contact tracing ensued as per routine public health guidelines. None of the physicians caring for Mrs. K or Mr. T were aware of the unusual respiratory infection that had started in Guangdong, China, spread to Hong Kong, and—at that point—Toronto.[1] (While Mr. T undoubtedly had SARS and was the critical case in triggering the Toronto outbreak, he did not meet the case definition for SARS because he had no history of either travel to China or contact with a person known to have SARS.)

Another early case in Toronto's first SARS outbreak (SARS I) was Mr. P, who had been in the emergency department bed next to Mr. T's at Scarborough Grace Hospital. He became ill about 1 week later. He was later admitted to the ICU, where he died 5 days later. His wife and several other family members were infected.

Mr. D was another Scarborough Grace patient infected in the emergency department. He became ill at home and was admitted back into Scarborough Grace Hospital in mid-March with acute shortness of breath. This symptom was ascribed to congestive heart failure. Since Mr. D had kidney failure, he was transferred to a regional dialysis center—York Central Hospital—without any warnings about the advisability of respiratory precautions. Mr. D proceeded to trigger the second large hospital outbreak of SARS I.[1]

Meanwhile, on the other side of Canada, a separate index patient who had traveled from Hong Kong arrived at the Vancouver general hospital with respiratory symptoms. The Vancouver hospital had been alerted to the danger of SARS, and this patient, unlike Toronto's Mr. K, met the case definition because he had traveled to China. This man was placed in strict respiratory isolation immediately and no secondary cases developed.[1]

THE PUBLIC HEALTH RESPONSE TO SARS I

On March 12, WHO declared a global health alert for a new disease being called severe acute respiratory syndrome (SARS).[9] SARS was predominantly occurring among healthcare workers in Hanoi and Hong Kong. Local, provincial, and national public health agencies failed to alert Toronto's hospital physicians about the new threat. Rather, clinicians discovered the WHO alert on their own and on March 13 reported the Toronto cluster to Health Canada. The following day, Health Canada began a coordinated public health response and information-sharing campaign.[1]

Ultimately, about 80% of the SARS cases in Toronto were hospital acquired by staff and patients.[10] Virtually all of the other Toronto SARS cases were from household contact with a person who had become infected in a hospital. This was truly a hospital-driven outbreak.

Mr. K's visit to Scarborough Grace Hospital Emergency Department was the lightning strike. Since Mr. K didn't even meet the SARS case definition, it was hard to see how the outbreak could have been prevented entirely. But, if a public health announcement had gone out earlier or if communications between hospitals and public health had been more robust, SARS I in Toronto would have been much less severe.

On March 23, the Ontario Ministry of Health closed Scarborough Grace Hospital to all new admissions after more than 50 SARS cases were linked to that institution. On March 26, a provincial emergency was declared and the Ministry of Health assumed a more direct role in managing Toronto's 26 acute care hospitals. On March 29, York Central Hospital was also closed when a new cluster of SARS cases appeared there.[1]

[ii] Procedures that were high risk for aerosolization of the SARS coronavirus, including intubation and nebulization, were thought to have contributed to SARS transmission in the healthcare setting and especially among healthcare workers.

Strict new infection control measures were mandated for all Toronto hospitals. Everyone entering a Toronto hospital—staff, visitors, and patients alike—was screened for respiratory illness. (Ironically, hospitals were the only places with active disease. People should have been screened on the way out, not on the way in.) All hospital staff wore full protective gear—gowns, respirator N95 masks, and gloves. Most outpatient services were cancelled, as was elective surgery. Public health officials ordered about 20,000 people—mostly staff, patients, and visitors from Scarborough Grace and York Central Hospitals—into quarantine. All hospitals were mandated to develop specialized SARS units.[1] After an investigation of the initial outbreak in Toronto, a press conference was held.

Toronto public health was overwhelmed by the sheer effort of trying to track tens of thousands of potentially exposed people. Epidemiologic information systems were also overwhelmed, not by the number of cases (which was never very large) but by the volume of alleged contacts. Ultimately, only a small fraction of people directed into quarantine were compliant. Jurisdictional and personality conflicts added to an overall sense of crisis and confusion.

Second-, third-, and fourth-generation cases appeared. All were directly linked to Mr. K by direct contact with SARS patients. Despite fears and numerous false alarms, there was little or no community (i.e., nonhospital) spread beyond the household contacts of hospital-acquired cases.

As the Easter and Passover holidays approached, Toronto braced itself for the anticipated explosion of cases. But then, like the morning dew, the crisis evaporated. It seemed that SARS was gone as quickly as it had come. In addition, the SARS outbreaks in Hanoi and Singapore seemed to be over, too, and the news from Hong Kong, with the largest outbreak, was encouraging.

COULD SARS II HAVE BEEN PREVENTED BY THE LESSONS LEARNED FROM SARS I?

On May 5, Dr. Osler organized a roundtable meeting for key stakeholders; they brought with them the evidence assembled to date. Meeting attendees included:

1. Dr. Bill Osler, who represented NTGH. NTGH had a major stake in the decision. If a SARS outbreak were declared, NTGH would be put into virtual lockdown for at least 20 days. Thousands of staff, inpatients, outpatients, and visitors would be ordered into quarantine. The hospital's reputation would be seriously damaged. On the other hand, if this were SARS and nothing were done, then everyone associated with NTGH would have been in grave peril.

   Question 1 What were the options available to NTGH? Did NTGH need to be closed? Did the risks of not declaring a SARS outbreak outweigh the immediate penalties?

2. Dr. Norm Bethune, who represented Toronto Public Health, the local public health agency in the forefront of the response to SARS. The efforts required to quarantine 20,000 people had exhausted public health staff. Although a recent CMAJ commentary[4] questioned the value of quarantine in SARS control, Toronto Public Health was committed to quarantine strategy. Furthermore, public health limited the designation of SARS to pneumonia cases with a direct contact with a probable SARS case—all tracing back to the Toronto index case in February. The NTGH cases lacked this crucial "epi link." Designating these cases as SARS would have thrown into question the whole definition of the outbreak, as well as its apparent control. Declaring a SARS outbreak at NTGH would plunge Toronto Public Health back into crisis.

   Question 2 Was the demand for an epi link too rigid? Did the case definition need to be broadened? Was mass quarantine a necessary response to an NTGH outbreak? Were less draconian responses available? Did the risks of an underresponse outweigh the penalties of an overresponse?

3. Dr. Chuck Best, an infectious disease consultant who had become the recognized SARS expert. He was the principal medical advisor to Toronto Public Health and the Ministry of Health and a prominent media "talking head." Dr. Best had reviewed the NTGH cases and concluded that they were not SARS. This was based on his clinical review of the cases, the absence of an "epi link," and negative serology. Dr. Best's laboratory had done the serology testing of these patients and he thought the testing was reliable, both sensitive and specific. A negative test meant no SARS. Dr. Best didn't think the cases of hospital-acquired pneumonia at NTGH were so unusual. He had seen thousands in his long career.

   Question 3 The reliability of clinical and laboratory diagnosis of SARS is uncertain. Should it be used as the basis for public health decision making? What are the differences between public health case definitions and clinical diagnostic criteria? What was the appropriate application of both in this context? Did Dr. Best really know the reasonable background rate of hospital-acquired pneumonia?

4. Edie Cavell, who was the chief nurse at NTGH. She had insisted that Dr. Osler invite her to the roundtable. Cavell

had only one real issue—worker safety. There had already been more than 30 cases of SARS among healthcare workers in Toronto, and three victims—two nurses and a doctor—had died. She was stridently opposed to lifting the respiratory precautions at NTGH until there were no more cases of pneumonia.

Question 4 Was her position reasonable? Were respiratory precautions for all staff, all of the time really necessary, or would stringent surveillance and strict isolation and precautions for those actually ill with pneumonia suffice? Are there occupational hazards associated with full precautions all of the time?

5. Dr. Fred Banting, who represented the provincial Ministry of Health. Dr. Banting was a nonpartisan civil servant, but he was aware of the political and economic ramifications of the issues. Declaring a SARS outbreak at NTGH would plunge Toronto back into the figurative SARS doghouse. WHO might reinstate its travel advisory and Toronto's protests would have very little credibility in the future. The economy would suffer, particularly the lucrative summer tourist trade. The minister's personal involvement meant that any backtracking would have a political impact. A provincial election was pending. Declaring a SARS outbreak at NTGH could bring down the government.

   Question 5 Are nonhealth issues—economic, political, and public confidence—valid considerations? How do we weigh the relative costs and benefits of these competing interests? Should these concerns even be on the table at all? What would be the economic and political costs of missing a SARS outbreak?

EPILOGUE

Box 1-3 describes the time line of the SARS outbreak, which ultimately led to over 8,000 cases, including 1,700 cases in healthcare workers. The case fatality rate among probable SARS cases varied from 4% (China)[iii] to 18% (Toronto). Up to 30% of patients required critical care.[11–13] SARS led to worldwide panic and a rapid response to the outbreak, including travel restrictions, quarantine measures, and collaborative research leading to the discovery of the new virus.[14] WHO announced in July 2003 the outbreak had been contained.

Ultimately, there were 250 confirmed SARS cases in Ontario, and 44 SARS deaths spread over almost 4 months, all in the Toronto area. Ontario's response to the first SARS wave, SARS I, was guided by implementation of the provincial emergency and the mandated decrease in elective and ambulatory hospital activity, the creation of SARS isolation units, implementation of personal protective measures for staff, and strict infection control measures in hospitals.[1] The real burden of SARS I was felt in a handful of hospitals, primarily Scarborough Grace and York Central, accounting for almost all of the cases.[1]

The Scientific Advisory Committee, comprised of Toronto physicians and public health experts, developed voluntary quarantine and isolation guidelines. Unfortunately, the participation of these individuals on the committee limited their provision of direct care, in part due to concerns that placing them at risk of contracting the virus would compromise the entire committee.[1]

Barriers to infection control included the lack of staffing and the inability to compare baseline rates for respiratory infections due to the paucity of epidemiologic data. In late April and early May, officials at North Toronto General Hospital and Toronto Public Health investigated multiple cases of pneumonia, including those on the orthopedic ward, and determined those cases to be due to postoperative infection.[1] On May 23, about 1 week after the WHO declaration that Toronto was SARS free, health officials declared a second SARS outbreak in Toronto (SARS II), despite the unclear epidemiologic link.

In the postincident evaluation, Dr. Richard Schabas, chief of staff of York Central Hospital, declared "SARS I was not avoidable. We were struck by lightning. Everything after that was [avoidable]."[1]

SARS II was more explosive than SARS I, with almost as many cases. SARS had been allowed to spread virtually unchecked in North Toronto General Hospital and St. John's Convalescent Hospital for several weeks. However, once announced, the second outbreak was controlled quickly. There were only a few new infections contracted after May 23—all in household contacts—and the last Toronto SARS case was probably infected around June 5. Then it was over. Really.

SARS was controlled quickly and relatively easily by identifying and isolating suspected cases and using strict infection control in their care. Mass quarantine of suspected SARS contacts was used more aggressively in Toronto than in other SARS outbreaks. Ultimately, more than 30,000 people were ordered into quarantine. Evidence subsequently confirmed that SARS was not infective during its incubation period—the target of quarantine—and quarantine is now discouraged for SARS control by WHO.[15]

Ultimately, SARS was controlled because it was only significantly infective to very close contacts of very ill people.

[iii] Advocates for traditional Chinese medicine were disappointed to learn that the lower mortality in China was a reflection of the younger, healthier demographics of the population affected there.

BOX 1-3 SARS Time Line

November 16, 2002	The first case of an atypical pneumonia is reported in the Guangdong province in southern China.
February 26, 2003	First cases of unusual pneumonia are reported in Hanoi, Vietnam.
February 28, 2003	World Health Organization officer Carlo Urbani, MD, examines an American businessman with an unknown form of pneumonia in a French hospital in Hanoi, Vietnam.
March 10, 2003	Urbani reports an unusual outbreak of illness, which he calls sudden acute respiratory syndrome or SARS, to the main office of the WHO. He notes that the disease has affected an unusually high number of healthcare workers (22) at the hospital.
March 11, 2003	A similar outbreak of a mysterious respiratory disease is reported among healthcare workers in Hong Kong.
March 12, 2003	WHO issues a global alert about a new infectious disease of unknown origin in both Vietnam and Hong Kong.
March 15, 2003	WHO issues a heightened global health alert about the mysterious pneumonia with a case definition of SARS after cases in Singapore and Canada are also identified. The alert includes a rare emergency travel advisory to international travelers, healthcare professionals and health authorities. CDC issues a travel advisory stating that persons consider postponing travel to the affected areas in Asia (Hong Kong, Singapore, Vietnam, and China).
March 17, 2003	An international network of 11 leading laboratories is established to determine the cause of SARS and develop potential treatments. CDC holds its first briefing on SARS and says the first 14 suspected SARS cases are being investigated in the U.S.
March 24, 2003	CDC officials present the first evidence that a new strain of a virus most frequently associated with upper respiratory infections and the common cold in humans called the coronavirus might be likely cause of SARS.
March 29, 2003	Carlo Urbani, who identified the first cases of SARS, dies as a result of the disease. Researchers later suggest naming the agent that causes the disease after the infectious disease expert.
April 2, 2003	WHO issues its first travel warning recommending that all non-essential travel to Hong Kong and Guangdong province be postponed.
April 3, 2003	WHO-sponsored team of international infectious disease experts arrives in Guangdong province to investigate the outbreak.
April 4, 2003	President George W. Bush adds SARS to the list of quarantinable diseases, which gives the CDC the authority to isolate persons who might have been exposed to the disease.
April 9, 2003	WHO investigative team gives initial report on Guangdong outbreak. The team found evidence of "super spreaders" who were capable of infecting as many as 100 persons.
April 12, 2003	Canadian researchers announce they have completed the first successful sequencing of the genome of the coronavirus believed to cause SARS.
April 14, 2003	CDC officials announce their laboratories have sequenced a nearly identical strain of the SARS-related coronavirus. The CDC version includes an additional 15 nucleotides, which provides the important beginning of the sequence.
April 16, 2003	A new form of a coronavirus never before seen in humans is confirmed as the cause of SARS according to Koch's postulates, which are four specific conditions that must be met for a pathogen to be confirmed as a causal agent of disease.
April 22, 2003	The CDC issues a health alert for travelers to Toronto, which is the epicenter of the Canadian outbreak of SARS. CDC director Julie Gerberding says the health alert alone is not a reason for potential travelers to avoid travel to the U.S. neighbor to the north, but it is part of the agency's effort to give travelers practical information to protect themselves from the global threat of SARS.

BOX 1-3 SARS Time Line *(Continued)*

April 23, 2003	The World Health Organization adds Toronto, Beijing, and the Shanxi province of China to the list of regions travelers should avoid to reduce the risk of becoming infected with SARS and taking the deadly disease back home with them. WHO officials say the travel advisory will remain in effect for at least the next three weeks.
April 28, 2003	WHO removes Vietnam from list of SARS affected areas, making it the first country to contain SARS successfully. WHO also lifts travel advisory to Hanoi, Vietnam.
April 29, 2003	The WHO lifts its warning against nonessential travel to Toronto, Canada, citing local measures to stop the spread of SARS. The affected area had not reported new cases in the preceding 20 days.
May 6, 2003	The CDC lifts its travel advisory for Singapore because no new cases of SARS had been reported in 20 days.
May 15, 2003	The CDC removes its travel alert for Hanoi, Vietnam because more than 30 days have elapsed since the last SARS symptoms were reported.
May 17, 2003	WHO extends its travel warning to include Hebei Province, China. A similar warning to postpone all non-essential travel is in effect for Hong Kong, Taipei, Taiwan, and several other areas of mainland China, including Beijing, Guangdong, Inner Mongolia, Shanxi, and Tianjin.
May 20, 2003	The CDC lifts its travel alert for Toronto, Canada, because more than 30 days have elapsed since the last case of SARS was reported there.
May 23, 2003	The WHO lifts its advisory against all but essential travel to Hong Kong and the Guangdong province of China saying the SARS situation in those areas has improved significantly.
May 26, 2003	The WHO changes the status of Toronto, Canada, listing it as an area where SARS has recently been transmitted locally after Canadian health officials report new clusters of 26 suspect and eight probable SARS cases linked to four Toronto hospitals.
May 31, 2003	The WHO removes Singapore from the list of areas where SARS has been transmitted locally. It has been 20 days after the last locally transmitted case was reported.
June 13, 2003	WHO lifts its travel warning against nonessential travel to several provinces in China, including Hebei, Inner Mongolia, Shanxi, and Tianjin.
June 17, 2003	WHO lifts its travel warning against nonessential travel to Taiwan. CDC downgrades its travel warning for mainland China to a travel alert, although a travel warning from both the CDC and WHO remains in effect for Beijing.
June 23, 2003	WHO removes Hong Kong from its list of areas with recent local SARS transmission after 20 days passed since the last SARS case was reported and isolated, which breaks the chain of human-to-human transmission and eliminates the risk of infection for both local residents and travelers.
June 24, 2003	WHO removes its last remaining SARS travel warning for Beijing, China. The city was also removed from the WHO's list of areas with recent SARS transmission after 20 days passed since the last new SARS case was isolated.
June 25, 2003	CDC downgrades its travel SARS travel advice for Beijing, China and Taiwan from "advisory" to "alert" status, which does not advise against travel to the regions but informs travelers of a SARS health concern and advises them to take precautions.
July 2, 2003	WHO removes Toronto, Canada from its list of areas with recent local SARS transmission after 20 days passed since the last SARS case was reported and isolated.
July 8, 2003	CDC lifts its SARS travel alert for Toronto, Canada after more than 30 days had elapsed since the date of onset of symptoms for the last SARS case.
July 9, 2003	CDC lifts its SARS travel alert for Hong Kong retroactively to July 1 because the last SARS case there was reported on May 31.

Source: Data from WebMD Health News, SARS: Timeline of an Outbreak. http://www.webmd.com/lung/news/20030411/sars-timeline-of-outbreak. Published 2003. Accessed March 1, 2011.

This explained the heavy concentration of cases in hospital staff and patients. SARS could spread efficiently in an unsuspecting acute care hospital, but it could not support sustained spread in the community. Once hospitals responded to the danger, SARS died out. SARS is best described as an animal (zoonotic) infection with limited capacity for human-to-human spread rather than a true human infection. Given its known infectivity and virulence, SARS was likely never a true pandemic threat.

Although it is difficult to estimate, SARS had a great economic impact—up to 2% of gross domestic product of the six affected cities. Hong Kong and Singapore were hardest hit economically, largely due to their high level of consumer trade and retail activity.[7] In Ontario's provincial election in October 2003, the progressive conservative government was defeated, in part because of its perceived mismanagement of SARS.

About the Authors

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