Progress in Global Surveillance and Response Capacity 10 Years after Severe Acute Respiratory Syndrome

[Announcer] This program is presented by the Centers for Disease Control and Prevention.

Ten years have elapsed since the World Health Organization, the WHO, issued its first global alert for an unexplained illness, which it named severe acute respiratory syndrome, or SARS. A few days later, the Institute of Medicine, the IOM, released a report, Microbial Threats to Health, which highlighted many of the issues and challenges raised by SARS. This anniversary provides us with an opportunity to reflect on the international response led by WHO to this new global microbial threat, a response that has resulted in control of the pandemic that resulted in greater than 8,000 cases and nearly 800 deaths in more than 30 countries and had a large economic impact.

Lessons of SARS

Many features of the SARS epidemic and the public health response are worth recalling because they provide reminders of challenges posed by the emergence of a new disease transmissible from person-to-person. Some of these features include the initial lack of field investigative capacity, reference laboratory testing, and reporting transparency from southern China, which resulted in a three-month delay in the reporting of severe unexplained illness to WHO; the important role played by an alert clinician in Hanoi, Vietnam, in the initial recognition and response to the illness; the rapid spread of illness to more than 30 countries; the effects on health care workers and family members who were most at risk for person-to-person spread of the infection; the ultimate success of early patient isolation, contact tracing, quarantine, and infection control measures; the importance of rigorous attention to biosafety in laboratory settings; the stigmatization of affected groups; the economic impact as a result of major disruptions in international travel and commerce; the identification of the mode and circumstances of cross-species transmission; and the role of "superspreaders" and superspreading events in the rapid dissemination of the illness. In addition, the leadership provided by WHO facilitated timely exchange of new information among clinicians, epidemiologists, and laboratory investigators around the world; these efforts included the formation of a global network of virology and pathology laboratories using modern diagnostic methods contributing to the rapid identification, characterization, and sequencing of the agent and the timely dissemination of critical information and guidance.

Emergence in Guangdong Province

Details are sketchy about the earliest phase of SARS spreading in Southern China, but the best retrospective analysis put the initial cases and clusters around mid-November 2002; spread to health care workers and family members was a critical aspect of the amplification of the epidemic during January 2003. Initial investigations were conducted by provincial public health authorities who did not recognize or failed to report the potential global implications of the

epidemic, and initial laboratory investigations incorrectly focused on a possible *Chlamydia*–like organism as the etiologic agent.

Superspreading Events Linked to the Hotel Metropole

Several superspreading events contributed to the dissemination of the virus. Some of the most dramatic examples included those associated with the Hotel Metropole in Hong Kong, the Amoy Gardens apartment complex in Hong Kong, Air China flight 112 from Hong Kong to Beijing, and an acute care hospital in Toronto, Ontario, Canada.

The episode at Hotel Metropole that contributed greatly to the initial cross-border spread of the disease was particularly noteworthy. The cluster of SARS cases at Hotel Metropole in Hong Kong in 2003, the first superspreading event recognized outside mainland China, was responsible for the spread of the epidemic from Guangdong Province to Canada, Vietnam, Singapore, and Hong Kong itself. In addition to the first 13 cases originally associated with the Hotel Metropole, a follow-up cohort study of guests from Canada, Germany, England, and the United States who stayed at the hotel concurrent with the index case-patient, a physician from Guangdong, identified an additional seven cases meeting the probable or confirmed case definition for SARS coronavirus infection. All 20 cases were associated with transmission of SARS on the ninth floor of the hotel, where the index case-patient had stayed for one night before becoming critically ill and being admitted to a local hospital the next day. Three deaths occurred among identified hotel guests, resulting in a case-fatality rate of 15 percent. Known secondary SARS cases were associated with at least 42 percent of the guest rooms on the ninth floor.

The high rate of infection among guests staying on the ninth floor at the Hotel Metropole is remarkable because of the absence of direct contact with the index case-patient. For example, one resident of Hong Kong who visited a friend on the ninth floor but was not a hotel guest likely acquired his infection during his visit; this person subsequently infected 143 people at Prince of Wales Hospital in Hong Kong. Epidemiologic evidence suggested an environmental route of SARS transmission. Indeed, environmental contamination with SARS was identified on the carpet in front of the index case-patient's room and three nearby rooms and on their door frames but not inside the rooms, and in the air intake vents near the centrally located elevators. Guest rooms had positive air pressure relative to the corridor, and there was no direct air flow of air between rooms. The lack of air flow between rooms and the absence of SARS coronavirus RNA detected inside guest rooms suggests that secondary infections occurred not in guest rooms, but in the common areas of the ninth floor, such as the corridor or the elevator hall. These areas could have been contaminated through body fluids generated by the index case-patient; other guests were then infected by fomites or aerosols while passing through these same areas. Efficient spread of SARS coronavirus via small-particle aerosols was observed in several superspreading events in health care settings during an airplane flight and in an apartment complex.

Recognition and Reporting from Hanoi

One of the guests at the Metropole, a business traveler, was hospitalized at the French Hospital in Hanoi. Called to the investigation into the subsequent illness of health care workers at the

hospital was Dr. Carlo Urbani, a WHO physician specializing in parasitology and who is known for having the mindset of an alert clinician and a strong dedication to the principles of public health. In a series of emails from Hanoi to his colleagues at WHO, Dr. Urbani sent some of the first messages of alarm and detailed descriptions of the clinical features of what would come to be known as SARS. His reports would lead to an aggressive response by the government of Vietnam, which quarantined the hospital staff and ultimately contained the epidemic there. It also raised the alarm with colleagues at WHO and the CDC who would work to characterize and contain the global epidemic. Dr. Urbani himself became infected and was hospitalized in Bangkok, where he insisted on repeated sampling of his own respiratory tract that provided some of the first isolates of the novel coronavirus. Dr. Urbani died on March 29, 2003, one of many health care workers who responded to those in need only to become victims themselves.

Health Care–associated Transmission in Toronto and Taiwan

Health care facilities played a substantial role throughout the SARS outbreak as sites of efficient transmission leading to acceleration of disease in communities. These facilities also played a critical role in stopping SARS through strict implementation of infection control practices.

The first cases of SARS in Toronto occurred very early in the global outbreak. A 78-year-old woman who stayed at the Metropole Hotel in Hong Kong in late February 2003 returned to Toronto before dying at home. However, her son had been infected and was subsequently admitted to a Toronto hospital, where nosocomial transmission led to more than 100 cases among patients, health care workers, and visitors. Prompt institution of airborne, contact, and droplet infection control practices led to an apparent cessation of transmission, and on May 14, WHO declared that Toronto was no longer a SARS-infected area. Control recommendations were relaxed, and the crisis appeared to have ended; however, unrecognized infection continued among a small number of patients and visitors. Eventually, transmission to health care workers, patients, and visitors resurged, leading to an additional 79 cases. After strict infection control practices and vigilance for SARS were reinstituted, the last case was recognized in mid-June, and no other cases were recorded thereafter.

The experience in Taiwan was very different. Soon after the recognition of the novel coronavirus in Hong Kong, officials in Taiwan instituted rigorous port entry screening and isolation of persons who had suspected SARS among returning travelers and their contacts. Public health and academic medical officials focused exhaustive efforts on accurately diagnosing cases of SARS in travelers. This approach appeared to work well for six weeks, suggesting that SARS could be prevented from entering the island. However, despite these measures, unrecognized transmission of SARS began occurring in the community. SARS in a hospital laundry worker at the large urban Ho Ping Hospital led to exposure of staff and patients and ignited an explosive outbreak that spread to other hospitals and the community. To contain the transmission, patients, staff, and visitors were quarantined in the facility. The use of “cordon sanitaire” had rarely been invoked in modern times. More than 1,000 persons were quarantined; some tossed soft drink bottles from windows with protest messages, others communicated the disarray within the facility through cell phone messages, and a few escaped. Public health officials rapidly pivoted to prevent a potential emerging infectious disease catastrophe. The epidemic curve for Taiwan reveals the dramatic rapid rise in cases resulting from the hospital outbreak. Strict infection control practices were mandated in all health care settings. SARS evaluation centers, or Fever Clinics, were

constructed outside hospital emergency departments. Community use of face masks, fever checks on entry to commercial establishments, and extensive community outreach and education were used to mitigate the impact of SARS. After two months of epidemic spread leading to more than 600 cases, SARS was eventually contained, and no further cases were reported.

The Legacy of SARS

The outbreak showed how rapidly a new, virulent pathogen could spread and how disruptive the effects could be. The palpable impact of SARS was translated into action in the form of pandemic influenza planning and surveillance efforts, a greater focus on global health security, improved laboratory and surveillance networks, and most important, the revision of the International Health Regulations, the IHR.

The legacy of SARS is evident in many other efforts, as well. New national public health agencies have been created in Canada and the United Kingdom. The WHO Global Outbreak Alert and Response Network has been strengthened. The Global Disease Detection Program was established at the CDC, with the aim of strengthening countries' efforts in training, surveillance, and outbreak response and the establishment of 10 Regional Centers by 2012. The International Association of National Public Health Institutes has been created. The Training Programs in Epidemiology and Public Health Interventions Network has expanded, and its regional partners have been strengthened.

Perhaps the most important legacy of SARS is the recognition of the critical need for a multilateral response, led by WHO, in the event of a rapidly moving but ultimately containable global epidemic. The central role of WHO in coordinating the laboratory network that identified the etiology and shared reagents, the epidemiology network that characterized the spread and identified the most effective control measures, and the policy and communications network that incorporated rapidly changing knowledge into measured travel advisories were critical for the control of the epidemic and a credit to WHO.

The One Health movement, which emphasizes the importance of interdisciplinary collaboration to address issues at the interface of human health, animal health, and environmental/ecosystem health, has gained momentum. The US Agency for International Development has supported the Emerging Pandemic Threats Program in an effort to strengthen prediction, detection, response, and amelioration programs in parts of the world shown to be at particular risk for emergence of new diseases.

Looking Forward

While many disease detection and control improvements have been implemented in the past 10 years, important gaps in global capacity and coordination remain. Some examples include the need to greatly strengthen and monitor the national capacity required for full compliance with IHR 2005, including ensuring that adequate numbers of trained personnel are available to support the response to a public health emergency, that surveillance systems are capable of detecting public health emergencies, that access is adequate to laboratory diagnostic capabilities that can identify a range of emerging epidemic pathogens, and that countries have adequate rapid response capacity for public health emergencies. In addition, there is a need for state of the art,

affordable countermeasures; workable approaches for equitable distribution of countermeasures when emergencies arise; a system to facilitate the conduct of research to evaluate treatment options during public health emergencies; and tools to assess the utility of social media in strengthening capacity for disease surveillance, event detection, and situational awareness.

I'm Dr. Mike Miller for *Emerging Infectious Diseases*, and I've been reading an abridged version of *Progress in Global Surveillance and Response Capacity 10 Years After Severe Acute Respiratory Syndrome.* You can read the entire article online now in the June 2013 issue of *Emerging Infectious Diseases* at cdc.gov/eid.

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