**SARS Timeline**

- **Nov 16 '02**
  - First cases retrospectively recognized, Guangdong, China

- **Feb 11 '03**
  - Acute respiratory reported in Guangdong by China MOH

- **Feb 28**
  - First SARS case – Vietnam

- **March 11**
  - Hong Kong and Vietnam report outbreaks in hospital workers

- **March 12**
  - WHO issues global alert

- **March 19**
  - Reported in U.S. and Europe

- **March 27**
  - WHO issues travel advisories

- **April 5**
  - China coverup admitted; SARS made top priority

- **April 9**
  - First SARS in Africa

- **April 14**
  - Sequence of suspected agent, a coronavirus, established

- **April 17**
  - India reports SARS

- **April 28**
  - Vietnam containing virus (WHO)

- **July 03**
  - Last case reported in China

- **Sept 03**
  - Laboratory case, Singapore, no secondary cases

- **Dec 03**
  - Laboratory case in Taiwan, no secondary cases

- **April 04**
  - Two laboratory cases with secondary spread (nine cases, one death) Beijing and Anhui
Global Distribution of SARS Worldwide

ERSI, May 2003
Effect of Travel and Missed Cases on the SARS Epidemic
Spread from Hotel M, Hong Kong
## SARS Hotspots (as of May 28, 2003)

<table>
<thead>
<tr>
<th></th>
<th># Probable Cases</th>
<th># Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>5322</td>
<td>321</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>1728</td>
<td>269</td>
</tr>
<tr>
<td>Taiwan</td>
<td>596</td>
<td>76</td>
</tr>
<tr>
<td>Singapore</td>
<td>206</td>
<td>31</td>
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<tr>
<td>Canada</td>
<td>148</td>
<td>26</td>
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<tr>
<td>United States</td>
<td>65</td>
<td>0</td>
</tr>
<tr>
<td>Vietnam</td>
<td>63</td>
<td>5</td>
</tr>
<tr>
<td>Philippines</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>Other Countries</td>
<td>62</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>8202</strong></td>
<td><strong>734</strong></td>
</tr>
</tbody>
</table>
Number of SARS Cases Reported Over Time (China)
Symptoms of SARS

- Cough
- High fever
- Severe pneumonia
- Difficult to distinguish from other respiratory diseases in early stages
Incidence Difference Across Different Age Groups (China)

(CDC, 2003)
Fatality Rates of Different Age Groups

CDC, 2003
Delayed Reporting of Emerging SARS Epidemic in China

- The initial cases of SARS appeared in Guangdong Province no later than Nov. 16, 2002.
- The WHO was notified by the Chinese Ministry of Health 3 months later, on Feb. 11, of an outbreak affecting 305 individuals, with 5 deaths.
- Ironically, the Chinese public was officially alerted of SARS epidemic at least one month later than a global alert issued by WHO on Mar. 12, when rumors had spread throughout the country.
Reasons for Delayed Reporting

- **Political:** unwillingness of local and central government to disclose the emerging disease epidemic
- **Economic:** to avoid coming side-impact on investment and tourism due to disclosure of the SARS epidemic
- **Technical:** lack of or under-developed public health surveillance systems to monitor a disease outbreak
The ongoing, systematic collection, compilation, analysis, and interpretation of data (e.g., regarding agent/hazard, risk factor, exposure, health event) essential to the planning, implementation, and evaluation of public health practice, closely integrated with the timely dissemination of these data to those responsible for prevention and control, as well as the public.
Initial Problems of the Chinese Public Health Surveillance System in Combating SARS

- No existing public health system monitoring an emerging infectious disease
- Insensitivity of responsible offices and officials to public health problems
- Low awareness, low and untimely reports of notifiable infectious diseases and health hazards by local clinicians, health practitioners, public health workers
- Data collected from ongoing surveillance sites are not timely analyzed, interpreted and, particularly, not disseminated
- Surveillance now down to township level
Structure of Coronavirus Virion

[Diagram of Coronavirus Virion showing the spike glycoprotein, hemagglutinin-acetyltransferase glycoprotein, membrane glycoprotein, small envelope glycoprotein, nucleocapsid phosphoprotein, and RNA.]

Holmes, NEJM, 2003
Etiology
Coronavirus Replication Cycle

Unique features:
- RNA-dependent RNA synthesis in the cytoplasm;
- Self-mediated cleavage of polyprotein into 3CLp, papain-like protease, RDRP, and other proteins.
SARS Diagnostics
Key Messages

- SARS diagnostic assays are sensitive and specific, but may not provide definitive diagnosis early in the illness
- Changes in the quantity, type, and timing of specimens collected may improve detection of SARS-CoV infection
- Rapid and accurate diagnosis of other respiratory pathogens associated with SARS-like illness may help rule out SARS-CoV infection and calm public fears
- Interpretation of test results must take into consideration possibility of false positives and negatives; a clear strategy to minimize such possibilities and to confirm test results are essential

CDC, 2003
Figure 2. Positive rates of specimen groups according to time of collection from onset of symptoms. The number of specimens tested is shown in Table 1.

Chan PKS et al. Laboratory Diagnosis of SARS. Emerg Infect Dis 10(5):827, 2004
Figure 3. Positive rates of specimens collected within the first 3 weeks.

Chan PKS et al. Laboratory Diagnosis of SARS. Emerg Infect Dis 10(5):828, 2004
Proportion of SARS Cases Who are Health Care Givers

- Nationwide: 17.3%
- Tianjin: 48.6%
- Inner Mongolia: 21.8%
- Beijing: 17.6%
- Shanxi: 12.0%
- Heibe: 8.7%
- Guangdong: 1.8%

April 26th-May 8th
Proportion of Cases who are Healthcare Givers has been Decreasing

Proportion

<table>
<thead>
<tr>
<th>Proportion</th>
<th>4/22</th>
<th>4/30</th>
<th>5/10</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.2%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21.0%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19.1%</td>
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</tbody>
</table>
Contact History of Confirmed and Suspected Cases

- Confirmed Cases:
  - 21.9% with contact history
  - 28.1% without contact history
  - 50.0% no information

- Suspected Cases:
  - 65.1% with contact history
  - 27.6% without contact history
  - 7.2% no information
Civet cat
Recommendations for Disease Monitoring in China

- Immediately establish a public health surveillance system for monitoring emerging infectious diseases or other health hazards or events.

- The system must have a wide net for providing related information, i.e., an information platform covering public and private health practitioners or clinicians, informal information from multi-media, etc., at various levels, and particularly from local health practitioners.
Recommendations for Disease Monitoring in China

Key Lessons:

“The local disease surveillance and response system is critical.”

- GAO: West Nile Virus Outbreak – Lessons for Public Health Preparedness
Recommendations for Disease Monitoring in China

- **Timely** compilation, analysis, and interpretation of collected data

- Feedback of information and, if necessary, alert the public of the existence of disease outbreak

- Particularly important, sufficient resources and efforts should be distributed to rural areas where a huge population resides, yet health infrastructures are extremely under-developed and qualified health services are not available
Recommendations for Disease Monitoring in China

- Should take advantage of the availability of internet for most of the county-level anti-epidemic Stations (local CDCs) and the increasing coverage of telephone service (450 million households now have telephones)

- National CDC should be authorized and mandated to provide timely information regarding disease outbreaks to the public through multi-media such as TV, radio, newspapers, magazines, internet and mobile phone services. This will rule out potential spread out of various rumors and prevent panic in the public
Recommendations for Disease Monitoring in China

- For the system to operate successfully, standards of data collection and analysis and measures for keeping confidentiality should be developed and enforced.

- **Training** of personnel involved in the system.

- **Legislation**
Definitions of Quarantine

- **Isolation**
  - Separation and restricted movement of *ill* persons with contagious disease
  - Often in a hospital setting
  - Primarily individual level, may be populations

- **Quarantine**
  - Separation and restricted movement of *well* persons presumed exposed to contagion
  - Often at home, may be designated residential facility
  - Applied at the individual or community level
  - May be voluntary or mandatory

*CDC, 2003*
A collective action for the common good predicated on aiding individuals infected or exposed to infectious agents while protecting others from the dangers of inadvertent exposure.

Meeting needs of individuals infected and exposed is paramount.

CDC, 2003
Key Issues to Consider

- Surveillance
- Clinical evaluation
- Infection control measures
- Patient isolation
- Engineering controls
- Exposure evaluation
- Staffing needs and personnel policies
- Access controls
- Supplies and equipment
- Communication

CDC, 2003
SARS Mysteries

Origin of SARS – animal reservoirs?

Is coronavirus the etiologic agent?

- Cases without antibody
- Non-cases with antibody
What proportion of exposed persons develop clinical disease and death?

- Proportion of exposed, infected and asymptomatic

Are there asymptomatic carriers?

- Reports of cases without known source of exposure
What causes “super shedders”?

- Host characteristics; e.g., age
- Agent characteristics – “virulent strain”

Is pathology caused by the virus or the response to the virus?

- AIDS patients appear to be resistant to SARS
Why Hasn’t SARS Re-emerged?

- SARS is transmitted through the respiratory route. These diseases, like influenza, tend to have a season cycle with resurgence in the late fall, winter and early spring.

- Potential sources of re-emergence:
  - Animal reservoir
  - Humans with persistent infection
  - Unrecognized transmission in humans
  - Laboratory exposure

- SARS most likely to recur outside the U.S.
  - Well-established global surveillance is important to recognition of first case
Prospects for an Effective Vaccine

- Development of a whole virus killed vaccine by Chinese
- Limited animal testing
- Full-scale field trials planned
- Concern about “immune enhancement” (increases susceptibility)
  - Requires long-term follow-up and challenge in animal models