Chapter 8: Republic of Singapore

Managing Outbreaks in Singapore - a Case Study of SARS

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1. Introduction

An outbreak is defined as the unexpected occurrence of two or more cases of a disease in a given area, or among a specific group of people, over a particular period of time. In an outbreak, we usually presume that the cases are related to one another or that they have a common cause. Contrary to popular opinion, it is not easy for an outbreak to occur. It requires the basic elements of disease causation and the chain of transmission to be all in place at the right time. Frequently, large numbers of people are affected in an outbreak and the cause is unknown. Fears abound that the disease might spread unless the source is found and hostility may even be shown towards individuals or stakeholders associated with the outbreak. Limited knowledge over the situation, little time for planning a scientific investigation, involvement of the press, and political pressure all add to the confusion. Into this setting comes the field investigator who must remain calm and collected, and work under circumstances fraught with unknowns, and deliver quick actions.

Fortunately, we have a time-tested approach towards managing outbreaks in field epidemiology[1-4]. This approach involves an understanding of the agent, the host and the environment. The agent is a pathogen (e.g., virus) that is necessary to cause human disease. The host is someone who is susceptible to the agent and his or her response may range from asymptomatic infection to illness to death. The environment is the physical, climatologic, biologic, social, and economic conditions that influence agent-host interaction. The agent may be carried from its source to the host directly, as in the case of contact transmissible diseases, or indirectly, as in the case of air-borne, vector-borne and food-borne diseases.

From the Ministry of Health's perspective, managing outbreaks involves the key components of public health surveillance, rapid response, and risk communications, and we explain these herein with special reference to a case study of the 2003 SARS outbreak in Singapore.

2. Public Health Surveillance

In Singapore, a total of 238 SARS cases (including 33 fatalities) developed onset of illness between 25 February and 11 May 2003. They comprised seven imported cases, 21 introduced cases (secondary to imported infections), and 210 indigenous cases (secondary to introduced infections). Of which, 121 were directly linked to contact with five cases in super-spreading events. Since the existing control practices were inadequate at that time, infection spread rapidly to involve health care workers, other patients, visitors and close family contacts. The success of surveillance systems in detecting the disease were facilitated by readily access to health care among the ill persons, and good information exchange. We observed that surveillance of probable cases could be undertaken even before confirmation of the microbial agent (infection was later found to be caused by a novel coronavirus and transmitted from person-to-person by close contact -- caring for, living with, or direct contact with respiratory droplets or body fluids of a suspect or probable case). Surveillance also picked up the phenomenon of super-spreading events, triggered by cases who were highly efficient in amplifying the virus and spreading it to ten or more people. The reasons were unclear but contributing factors included clinical severity of the disease, presence of co-morbid conditions which masked the tell-tale symptoms of SARS, and failure to isolate the cases early.

Outbreaks are usually uncovered by alerts from astute doctors and other health care providers. Occasionally, we are alerted by the media or members of the public who know of cases with a sudden illness. Data from various sources must be systematically brought together and evaluated for meaningful interpretation. This is the role of surveillance, which comprises the ongoing collection, analysis and interpretation of case notifications, syndromic events, and laboratory and environmental data essential for the planning, implementation and evaluation of disease control practices. Through surveillance, we build up a total public health picture by tracking emerging diseases and monitoring the pathogens, vectors and other determinants. If the surveillance system shows a sustained increase in incidence over the usual background level of reported cases of a particular disease, an outbreak is probable and requires further investigation. A well established system provides early and prompt identification of an outbreak. It also enables us to observe and predict dangers posed by the outbreak, and to understand the factors contributing to its spread. At the same time, surveillance is closely integrated with timely dissemination of information to all those who need to know. Ongoing data exchange within the medical and public health community is necessary to create situational awareness and facilitate disease control.

3. Rapid Response

As the SARS outbreak was characterized largely by contact transmission in the hospital and household setting, the national level responses to control the situation focused on three areas: (a) hospital infection control; (b) contact tracing and quarantine; and (c) border health controls.

3.1 Hospital infection control - The health care institutions constituted the battleground in the fight to prevent further spread of the disease. Stringent measures were instituted to prevent and contain SARS in the hospitals, national health care centers, nursing homes, medical, dental and traditional Chinese medicine clinics. Health care workers were required to wear N95 masks, gloves and gowns and practice frequent hand-washing after contact with every patient. Goggles were also required in isolation facilities, emergency departments and intensive care units. When performing high risk procedures such as bronchial aspiration and intubation, positive airway pressure respirator hoods were used. All health care institutions were also required to monitor their staff closely through twice or thrice daily temperature monitoring and strict instructions were given to disallow any staff who had fever or was unwell to work. To prevent cross-infections between hospitals, no inter-hospital transfers of patients were allowed. Doctors and other health care workers in the private hospitals were required to register to work in one hospital only. In addition, all visitors had to be registered so that they could be traced quickly. The hospitals also restricted the number of visitors to just one per patient and strictly enforced the visiting hours. This measure was stepped up one notch from 29 April to 31 May 2003, when no visitors were allowed in all public sector hospitals with the exception of pediatric and obstetric (delivery) cases which were allowed just one visitor each day. The measures were deemed to be effective and sufficient when no more health care workers contracted SARS after 13 April 2003.

3.2 Contact tracing and quarantine - Contact tracing was established for the identification and quarantine of all close contacts of probable/suspect SARS cases and observation cases in whom SARS could not be ruled out. The close contacts involved immediate family members and persons who worked full-time in the household; health care workers, patients and visitors exposed in primary health and hospital facilities; and other contacts who had more than passing exposure in specific locations. Home quarantine was deemed the most logistically feasible means of quarantine for the large numbers of contacts. Persons

who were quarantined were given instructions to monitor their temperatures twice daily and to call for the dedicated ambulance service if they were unwell. Singaporeans served with the Home Quarantine Order (HQO) could choose to be quarantined at home or at a designated quarantine center as "temporary home". Travelers to Singapore served with the HQO could choose to leave Singapore within 24 hours so long as they were asymptomatic, or to remain in Singapore at a designated quarantine center. Quarantined persons were monitored daily by telephone to makesure that they were well and did not break quarantine (they had to appear before an electronic picture camera each time they were called). The measures came across to the public as hard but necessary. Later, the approach was softened with home visits by nurses and an HQO monetary allowance.

3.3 Border health controls - While the main battle against the disease continued in the hospitals, health screening at the border checkpoints formed a defense against export and import of infection. To prevent the export of SARS cases, mandatory screening of all outgoing travelers was conducted at airport and the seaports, and all bus travelers at land checkpoints. Temperature checks were also conducted on incoming passengers. For ease of tracing, all visitors were required to complete a Health Declaration Card. The declaration covered symptoms of SARS, contact and travel history as well as personal particulars and address. In case travelers from SARS-affected areas were incubating the disease, they were given a Health Alert Notice explaining the disease and how they could get medical help if symptoms appeared. All inbound and outbound passengers and crew were subject to health screening using thermal imaging scanners. Persons picked up by the scanners had their temperatures re-checked by nurses and were referred for examination by doctors at the airport if found to be febrile. Suspect cases were sent to Tan Tock Seng Hospital for further assessment and admission for isolation. Outgoing travelers from the airport and seaports were also asked to declare symptoms of SARS and contact history with SARS patients. Through the WHO, Singapore informed other countries whenever there were possible contacts of SARS cases who traveled out of the island. Singapore reached a multi-lateral agreement on information exchange in relation to travelers within the ten ASEAN countries, China, Japan and Korea. In view of the high volume of people movement to and from Malaysia daily, a special bilateral arrangement was also set up between the two governments for contact tracing and operations when persons with fever were detected at the land checkpoints. On 31 May 2003, WHO, satisfied with the effectiveness of the measures taken, took Singapore off the list of countries with local SARS transmission.

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In responding to an outbreak, speed and accuracy are both essential or else credibility could be compromised. The epidemiological approach to manage an outbreak involves a number of steps: establishing proper case definition and existence of the outbreak; verifying the diagnosis of reported cases; active case finding to locate all cases; describing the outbreak in terms of time, place, and person; undertaking analytical studies (e.g., case-control study); formulating our hypothesis on etiology; instituting control measures; and communicating the findings and actions taken. While these steps are mentioned in conceptual order, several steps may take place concurrently or in a different order. For example, control measures should be implemented as soon as the source of infection and mode of transmission are known, which may be very early in an outbreak.

The primary objective of outbreak response is to control the outbreak by breaking the chain of transmission. This must be the priority, especially when cases are continuing to occur frequently. We do this by characterizing those at risk in the outbreak, and formulating control measures to prevent additional cases. The success of control measures depends on how much we already know about the agent and its mode of transmission since we cannot institute control measures without this information. The secondary objective of outbreak response is to understand disease etiology, i.e., the cause of the outbreak and associated risk factors. This shifts the focus towards identifying why the outbreak occurred and using that information to prevent future recurrence. Each outbreak is a natural experiment that offers a unique opportunity to study the natural history of the disease in question. For a newly recognized disease, we see opportunities to study the clinical spectrum of the illness and specific risk factors. For a familiar disease, we learn more about the impact of various control measures and the usefulness of different epidemiological and laboratory techniques. Such information is useful to improve control and prevention efforts.

4. Risk Communications

The SARS outbreak was a crisis not just of public health but also a crisis of confidence in good governance. During the outbreak, we were inundated with requests by members of the public daily for information on what mitigation measures could be taken. The tremendous pressure for coordinated flow of timely information enabled a more organized management system to emerge. Activities of daily living and business had to continue, and the role of the

government was to work with the public, private and people sectors to guard against infection in the community. To rally the community in support of disease prevention and control, simple measures were highlighted for everyone. Emphasis was placed on social responsibility and personal hygiene, including the value of hand-washing and respiratory etiquette. If people had fever, they should seek proper medical attention instead of going to work or school. Those that were ill were advised to wear a surgical mask to protect others. Fever checks became a norm and daily temperature taking was instituted in all national schools and public institutions. Private sector workplaces were also encouraged to conduct temperature taking of their employees. In addition, organizers of mass events such as concerts, social gatherings and recreational activities were encouraged to screen participants for fever prior to admission. Campaigns to spruce up the environment through good hygiene and sanitation were introduced to guard against fomite transmission in public areas, including on-board public transport. A "Singapore OK" programme was introduced, which mobilized the community to play their part in promoting cleanliness and hygiene. Practical advice on many mitigation measures gave confidence to the public that the authorities were in control of the situation.

One crucial consideration in managing outbreaks is the communication of outbreak findings and actions taken to all those who need to know. This feedback process is important and may even take the form of a media conference or press release. Credibility is built up when we are able to describe, in a scientifically objective manner, what happened, what was found, and what is being done about it. The recommendations for action must be logical, and defensible based on the evidence. When an outbreak is in the limelight, public, political, and legal concerns might override scientific concerns. Also, from time to time, rumors of something strange going around in the environment require investigators to "chase" potential health hazards. Such investigations almost never identify a link between the disease and the suspected source. Nevertheless, it is essential to be responsive to public concerns, even if the concern has little scientific basis. We also see these instances as opportunities to educate the public. At the end of each outbreak, it is always a good practice that the lessons learned be documented in the form of a peer reviewed scientific publication. This extra effort is desirable because it subjects our actions to scrutiny and improvement, and serves as a reference for professionals encountering similar situations in the future. A report that finds its way into the medical literature contributes to the scientific knowledge base of epidemiology and public health.

5. Conclusion

An integrated and well-run surveillance and response system empowers decision-making because it establishes baselines and epidemic thresholds, identifies trends of new and emerging threats, and guides resource allocation for disease control. Managing outbreaks requires proper surveillance, response and communications. It involves a combination of diplomacy, logical thinking, problem solving, quantitative skills, epidemiological know-how, and judgment. These skills can only improve with practice, mistakes, and more practice.

6. References

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Picture 1: *Taking food and environmental samples*

Picture 2: *Conducting a survey in the community*

Picture 3: *Screening blood for malaria parasites*

Picture 4: *Interviewing young students in a school outbreak*