

**Report of the Outbreak of
Severe Acute Respiratory Syndrome
In Ward 8A of PWH**

Introduction

The Prince of Wales Hospital (PWH) was suddenly hit by an unknown virus in early March 2003, causing an outbreak of infection amongst a large number of patients and staff within a very short timeframe. The incident first came to notice on 10 March. The index case was identified on 14 March. The total number of secondary cases being infected directly by the index case was 142. The sudden attack of this unknown infection, affecting a sizable number of the medical and nursing staff, had virtually paralyzed the whole hospital. Finally, the last secondary case of the outbreak was admitted on 22 March. This report provides an account of the outbreak in Ward 8A and the management responses from the beginning to the end of March.

Outbreak at Ward 8A

A. Sequence of Events

2. The hospital management was first notified of a possible infectious disease outbreak on 10 March 2003 with a total of 11 staff health care workers (HCW) on sick leave from Ward 8A and the Medical Department. Ward 8A was immediately closed to admissions and visitors. A detailed account of the sequence of events is shown in Appendix I.

3. In the next morning on 11 March, the number of HCW on sick leave increased to 14. Contact was made with the Department of Health New Territories East Regional office. The hospital was also informed of 2 other HCW admitted into other hospitals in Hong Kong, one of whom was subsequently diagnosed to have pneumonia. At the same time, 3 cardiothoracic surgeons who had visited 8A in the past week were reported to be sick. One was diagnosed to have pneumonia and was admitted into the private ward at PWH during the day. The hospital management considered an infection outbreak was highly likely and immediately called back all staff members who were on sick leave for physical check up in the evening.

4. An emergency medical clinic was set up in Conference Room 2 on 2/F of the hospital. The area was isolated for restricted access. A total of 50 staff HCW were called back to have physical check up, blood tests, nasopharyngeal aspiration and chest x-ray. The A&E Observation Ward was vacated for taking in staff that required admission. A&E observation was relocated to Ward 5E. A total of 23 staff HCW were admitted immediately, 8 with x-ray signs of pneumonia and 15 with high swinging fever of more than 38 degree Celsius. The others were asked to return to follow up in the A&E Department the next day.

5. A screening clinic was set up in the A&E Department, with two cohorted rooms, to monitor the progress of the symptomatic staff that had not been admitted. They were followed up with blood tests and chest x-ray daily. The screening clinic also provided medical consultation to other staff that had high fever and were suspected to be suffering from atypical pneumonia. The normal Staff Clinic was confined to take care of the afebrile staff members only. The number of attendance in the A&E screening clinic rapidly increased to 90-100 per day.

6. Much effort was made at the initial stage to identify the index case. This was done through detailed listing of the time lines and relationships of all the patients and staff HCW admitted. The possible index case was identified on 13 March and the patient was immediately isolated in Ward 8A. This was confirmed the next day with the Department of Health. On 18 March, it was further postulated that the use of nebulizer for administering Ventolin to the index patient on 8-12 March in the ward accounted for the extremely high attack rate among the HCW and visitors who visited Ward 8A during that period.

B. Re-constructing the Index Case Story

7. On 19 March, the Department of Health announced that the index case had visited the 9/F of the [REDACTED] in Kowloon on 21-22 February, where the professor from Guangzhou ^{Hotel} also stayed. The Guangzhou professor was subsequently admitted into KWH and died shortly after from atypical pneumonia. Several other cases were affected at the same period during their visit to the same floor of the hotel. For our index case, he developed fever on 24 February and visited the PWH A&E Department for the first time on 27 February. He was diagnosed to have upper respiratory tract infection and discharged without being admitted. He returned to the PWH A&E Department on 4 March and was admitted. During his two visits to the PWH A&E Department, he infected a total of 6 A&E HCW.

8. On 8 March, the Chinese University of Hong Kong was having examinations for the third year medical students. The examination lasted for two days. All examiners were subsequently admitted for atypical pneumonia. Among the medical students, those who had their examinations before 10.40 a.m. on 8 March did not get the disease. The medication order of using the nebulizer to administer Ventolin for the patient was made in the morning ward round of 8 March. The nurses administered the medication later in the morning. Other medical students having examinations after 10.40 a.m. on 8 March and during the next day all got the disease. All nurses in Ward 8A, except one who had taken leave before the incident, as well as all doctors and medical students who contacted the index case and his neighboring patients, including the cardiothoracic surgeons, got the disease.

9. The index patient was admitted initially with high fever. Subsequent chest x-rays after admission showed increasing pneumonic changes. He was treated with antibiotics and the fever subsided with the chest x-rays improved.

C. Epidemiology & Statistics

10. The index cases infected a total of 142 secondary cases (cases being infected through direct contact with the index case) as he visited the PWH A&E Department and stayed in Ward 8A. Among the 142 secondary cases, 28 were patients, 50 were HCW, 17 were medical students, 42 were visitors to Ward 8A and 5 were relatives of the index case. There were 58 tertiary cases (cases being infected through contact with the secondary cases), including 21 cases in the community and 37 HCW in the hospital. Among the 21 tertiary cases in the community, 2 were private general practitioners; the rest were relatives of the secondary cases. There was no 8A visitor among the tertiary cases. Among the 37 HCW, reasons for their infection were studied; the results are summarized under the section on infection control. The incubation period of the infection was noted to be 2-7 days. The epidemiological curve of the Ward 8A outbreak is shown in Appendix II.

11. In addition, the Department of Health had made contacts with a total of 97 relatives of the secondary cases in the community. Among these relatives, 5 was noted to have fever and 1 was subsequently diagnosed to have atypical pneumonia, making the crude attack rate to be around 3%.

Organization

12. The Cluster Meeting on Atypical Pneumonia was organized on 13 March to serve as the steering mechanism in fighting the disease outbreak, and to make decisions on strategies and policies in disease and infection control. Members included senior members of the cluster management, the Chiefs of Services and various clinical heads, heads of PWH Infection Control Team and the Dean of CUHK. The meeting was later renamed the Cluster SARS Meeting.

13. Under the Cluster Meeting on Atypical Pneumonia, senior members of the cluster and clinical management teams were appointed to be responsible for different areas in fighting against the outbreak. For the cluster management, these responsibilities are assigned based on the current portfolio of the Hospital Chief Executives and Service Directors.

Clinical Management

A. Organization

14. On the second day of the outbreak, the Medical Department was divided into a "dirty" team and a "clean" team. The dirty team was responsible for taking care of the staff and patients diagnosed to have atypical pneumonia (or SARS); the clean team was responsible for taking care of the other medical patients. The two teams would not cross cover in order to prevent the clinical team members from cross-infecting each other. Until early April, or before the AHNH outbreak, it was the cluster policy that all patients with atypical pneumonia would be admitted into PWH, with a view of keeping all the other hospitals within NTEC clean.

B. Medical Treatment

15. The medical treatment is summarized in the paper titled "A Major Outbreak of Severe Acute Respiratory Syndrome in Hong Kong" by Lee et al published in the New England Journal of Medicine at www.nejm.org on 7 April 2003. The patients were initially treated with cefotaxime and clarithromycin (or levofloxacin) to target common pathogens causing community-acquired pneumonia. Oseltamivir (Tamiflu) was also given initially to treat possible influenza infection. If fever persisted for more than 48 hours and the blood count showed leukopenia, thrombocytopenia, or both, oral ribavirin and corticosteroid therapy was given as a combined regime. Patients

with persistent fever and worsening lung opacities were given intravenous ribavirin and corticosteroid therapy. Patients in whom hypoxemia developed were given oxygen through a nasal cannula. Patients were admitted to the ICU if respiratory failure developed.

Disease Control

A. Disease Control Center

16. The Disease Control Center was set up in Conference Room 2 on 2/F of the hospital on 12 March, the next day following the admission of the first 23 staff patients. Dr Nelson Lee from the Department of Medicine set up the database for collection of clinical and epidemiological data to facilitate contact tracing and subsequent data analysis. The day-to-day operations of the center and the collation of data were overseen by Dr Louis Chan from the Department of Obstetrics and Gynecology. The center was in close contact with colleagues from the Department of Health to ensure timely exchanges of information for contact tracing and disease control.

B. Contact Tracing

17. On 13 March, colleagues from the Department of Health were invited to station in the Disease Control Center to facilitate contact tracing. It was agreed that the Department of Health would be responsible for the contacts in the community, while the hospital would be responsible for tracing contacts among its own staff. Dr SF Lui, Service Director in Risk Management & Quality Assurance, was responsible for contact tracing within the hospital. Detailed listing of the time lines and relationships of all the admitted patients and staff members were done, which enabled the early identification of the index case and the use of nebulizer as the source of spreading of the virus through aerosols.

C. Isolation of Patients and Wards

18. The first batch of 23 staff HCW was first admitted into the A&E Observation Ward on 11 March for isolation. In the subsequent few days, the number of patients increased rapidly. By 18 March, a total of 5 additional medical wards were opened for observation and isolation of the suspected or confirmed atypical pneumonia patients. The 5 wards were 8D, 8B, 11B, 10C and 10D. As the A&E

Observation Ward was extremely crowded and the condition was considered to be suboptimum, the patients were relocated to 10A and 10B for continuous treatment. Hence, by 18 March, there were a total of 7 wards taking care of patients with suspected or confirmed atypical pneumonia. In addition, patients in the original Ward 8A were cohorted for control of spreading of the infection. The number of atypical pneumonia or SARS patients reached its peak on 28 March with a total of over 160 confirmed cases. Wards on 9/F were also recruited to provide the service. The wards are organized functionally into the infection triage, SARS triage, confirmed SARS and step down wards.

D. Hospital Visiting

19. Ward 8A was immediately closed to admissions and visitors on the first day of the incident. Subsequently, the hospital adopted a policy of restricting visitors by limiting the number of visitors and to the immediate family only. Precautionary measures for droplet infection were required for all visitors. The decision was made in the light of the severe anxiety and psychological stress that the admitted patients were facing at that moment. There was the concern about possible threat to the community should the patient refuse to be admitted due to strict isolation. Throughout the period, the hospital was also maintaining its outpatient services and the oncology services (for patients who required chemotherapy and radiotherapy treatment as well as clinical follow up). The oncology patients, in particular, were given the choice of being referred to other Oncology Centers in HA. But virtually all of them preferred to stay in PWH. It is worth-noting that there was no visitor amongst the tertiary cases. The policy was reviewed by the CDC infection control experts on 26 March who did not recommend any change. However, HA decided to ban all visitors to the atypical pneumonia wards on 27 March.

Communication

A. Communication with HAHO

20. External communication with the media and the public was conducted through HAHO. There was good communication with HAHO right from the outset of the outbreak. Round-up meetings were held daily at HAHO from 18 March onwards to ensure the provision of adequate mutual support and coordination among the hospital clusters. Ad hoc meetings were held between CE and the hospital management to constantly review the status of disease control and its impact on

services. From 11 to 22 March, CE paid a total of 8 visits to PWH, including 4 ad hoc meetings, 3 ward visits and 1 courtesy visit together with CE/SAR. The close communication ensured that decisions could be made very rapidly in response to the changing challenges from the outbreak at its initial days.

B. Internal Communication

21. At the beginning, there was much panic in the hospital. Internal communication was given the highest priority and the following measures had been taken since the first day of the outbreak.

- (a) A hotline was immediately set up on 12 March to address staff concerns.
- (b) The first HCE staff forum was held on 13 March. Subsequent to that staff forum was held daily from 17 March onwards to ensure timely communication.
- (c) A special "hot" section was created in the NTEC intranet to update colleagues on the situation reports, infection control guidelines, staff support measures and other matters related to the outbreak.
- (d) A situation report was produced daily from 14 March onwards. The reports were posted onto the NTEC Intranet and were also sent to the PWH HGC Chairman and members for information.
- (e) The Chairman of the PWH Doctors' Association was invited to sit in the Cluster Meeting on Atypical Pneumonia to reflect frontline concerns and to help communication.

Infection Control

22. The cluster policy on infection control has all along been focusing on promoting the culture and appropriate practices as well as managing the underlying risks. Much emphasis was being put on training, policing and auditing of the infection control practices. Unfortunately, the outbreak came so sudden that it caught many colleagues off guarded. As a result, many staff members were infected and became the secondary and tertiary cases. It also exposed the fact that the hospital had not had a strong culture in infection control and the general awareness of hospital infection was not high before the outbreak. The following provides an overview on infection control at PWH and NTEC during the outbreak.

A. Organization

23. The Hospital Infection Control Team, led by the consultant in microbiology with two infection control nurses, was responsible for developing specific guidelines in the management of atypical pneumonia, recommending standards in personal protective equipments (PPE), providing training to staff on infection control measures, and policing and auditing the infection control practices among staff. Subsequent to the appearance of 37 tertiary cases, it was considered that the organization of infection control in the hospital would have to be enhanced and to be expanded to the cluster level. The NTEC SARS Prevention Task Force was set up on 27 March. This was a joint task force of the Infection Control Team and the Risk Management Team of the cluster. The joint task force was chaired by Dr SF Lui, head of the Risk Management Team. Infection Control Officers were also appointed at the hospital, department and ward/ unit levels.

B. Guidelines and Standards

24. A series of guidelines on infection control in various hospital wards/ areas, the precautionary measures and the management of patients having or recovering from atypical pneumonia was issued on 13-21 March. These guidelines were derived from the general infection control guidelines that the cluster had put in place prior to the outbreak. They were customized to meet the specific circumstances arising from the atypical pneumonia outbreak. The guidelines also included the cluster standards in the provision of PPE for staff. They were all posted on the NTEC intranet for easy access. These guidelines and standards were subsequently modified and updated in response to changing circumstances and results of the reviews and audits.

C. Communication

25. The first training session on infection control started on 13 March. Since then, sessions were held at least twice weekly. Initially, these sessions focused on the basic infection control concepts and practices. Later on, the emphasis was shifted to correcting the wrong practices. In order to specifically enhance the understanding of infection control among the minor staff, a special staff forum was held on 25 March to address their common misconception and wrong practices. Separate briefing was also conducted on 28 March for the ward managers on infection control risks, culture and extra infection control measures that should be taken in order to prevent secondary infection. Since the setting up of the NTEC SARS Prevention Task Force, an

enhanced programmed was launched which included assessment of staff knowledge, auditing their compliance and video recording some of their practices.

D. Review and Audit

26. The CDC experts on infection control, [REDACTED] and [REDACTED] were invited to review the infection control measures at PWH on 26 March. Specific questions were raised in relation to the restricted visitor policy, the need for doing terminal disinfection in Ward 8A, and the infection control measures and practices promulgated since the onset of the outbreak. The experts considered the infection control measures were up to international standards but there was a need to beef up implementation; no recommendation was made on the terminal cleaning of the 8/F. Meanwhile, the cluster risk Management Team had also conducted a review of the secondary infection of atypical pneumonia amongst HCW in PWH, i.e. the tertiary cases, leading to subsequent enhancement of the infection control guidelines for the cluster.

Manpower Deployment

27. The sudden outbreak of the disease and the large number of staff being affected in the first wave of the epidemic required rapid response from the hospital management to mobilize staff from other departments to maintain the service. Within the month of March, a total of 159 nurses were deployed from other departments and hospitals to work in the SARS patient services, of which 138 were deployed internally from within the cluster and 21 were from other hospitals. In addition, a number of doctors from other clusters volunteered to help on the medical side. House officers from all clinical departments were also rotated to work in the medical clean teams, 4 at a time, to allow more medical team members to be deployed to take care of the atypical pneumonia patients.

Contingency Measures

28. With a total of 87 HCW being affected in the epidemic, the hospital operation was basically paralyzed. In particular, the Medical Department was most heavily hit with over 15 physicians infected, mostly from the cardiac team. The cluster management had to closely monitor the epidemic, clinical and operational situations, carefully gauge the staff morale, and timely liaise with CE and HAHO for decisions and contingency measures.

29. Throughout the epidemic, the hospital was able to maintain its services for the oncology patients requiring surgery, chemotherapy and radiotherapy. However, the other services were very much interrupted. The medical clinics were reduced to drug dispensing clinics so that the chronic patients were only given their repeated drug prescriptions but no medical consultation; all new case clinics were stopped. The obstetric and gynecological services were relocated initially partially and later fully to AHNH. The emergency medical services were closed in two stages: first, the diversion of non-atypical pneumonia medical emergencies to AHNH or NDH starting 13 March; second, the diversion of medical emergencies to the other clusters starting 17 March; third, the full closure of the A&E Department from midnight onwards on 19 March. The A&E service was closed for 21 days and was re-opened on 30 March for the walk-in patients. The decision of full closure of the A&E was made in the context of increasing number of patients being admitted and the surge in need for ICU beds starting the second week of the epidemic. It was also noted that quite a number of patients started to deteriorate in the second week of admission.

Staff Support

30. On 11 March when the first group of staff was called back and first 23 staff members were admitted, a hotline was set up to address staff concerns on the infection outbreak. There were a lot of anxiety, fear and panic expressed in the first staff forum held by the HCE on 13 March. In particular, many colleagues expressed concerns if they could go home on working in the wards serving the atypical pneumonia patients. 40 rooms in the staff quarter were prepared to allow staff to stay if they prefer not to go home after work. Additional staff support measures were introduced in the subsequent days which included the organization of staff support teams and groups, briefing sessions to staff on crisis management, stress debriefing, improving showering facilities for staff after work, assigning a rest bay in the staff quarter for staff feeling unwell, and coordination with the Head Office to set up an Oasis hotline. As there was uncertainty on the incubation period and the infectivity of the virus at the initial stage of the outbreak, a 14-day "wash-out" period was adopted for all staff that had worked in the high risk areas as a temporary measure. This policy was subsequently dropped by the end of March as more evidences were available on the virus and the infection.

Supply of Protective Apparel and Drugs

31. The adequate supply of protective apparel and drugs, in particular IV Ribavirin, was ensured through close liaison and coordination with the corresponding sections in HAHO. In general, supplies were not an issue throughout the epidemic.

Conclusion

32. The outbreak caught everyone unprepared. However, it ignited much professional spirit in the hospital in dealing with the epidemic attack. During this period, the cluster management and the clinical teams were working very closely to provide effective treatment for the patients and to contain the spread of disease in the community and infection amongst HCW. Unfortunately, there is still one mortality among the HCW. Mortalities among patients were mainly the elderly ones or those with chronic illness. Apart from the initial few days when there was much anxiety, fear and panic, the staff morale settled very quickly and the team spirit within the hospital remained high. During the whole battle, colleagues from various departments were joining the SARS teams on a voluntary basis. The cluster and hospital management was able to provide the necessary supports to the frontline colleagues so that there were relatively few complaints despite the large volume of patients. This was due very much to the efforts made in communication as gathered from the feedback from many frontline colleagues.

33. Nevertheless, the sudden outbreak of SARS also exposed considerable weaknesses in the hospital. These include vulnerability of the lack of expertise in infectious diseases, the weak infection control culture and inadequate general awareness on good infection control practices, and the outdated physical facilities such as crowded bed space and corridors, no isolation room, old air-conditioning design, inadequate air flow and ventilation, lack of changing, washing & showering facilities. Some of these would require long term re-planning of the hospital.

Outbreak of SARS in Ward 8A of PWH

Sequence of Events

Date	Event
10 Mar	<ul style="list-style-type: none"> • 11 staff from 8A and Medical Department applied sick leave; 7 doctors, 4 nurses. • 8A closed to admission.
11 Mar	<ul style="list-style-type: none"> • 14 staff from 8A applied sick leave; informed 1 staff admitted Union Hospital, 1 admitted KWH; staff admitted KWH developed pneumonic changes in CXR in the afternoon; 3 Cardiothoracic surgeons reported sick in the afternoon, 1 admitted private ward with pneumonia. • Contact with Department of Health New Territories East Regional Office. • 50 staff on sick leave called back in the evening for screening; emergency clinic set up in Conference Room 2 on 2/F; 23 admitted, 8 with CXR changes, 15 with high swinging fever; A&E Observation Ward vacated for admission of staff; A&E observation relocated to 5E.
12 Mar	<ul style="list-style-type: none"> • More staff noted to have CXR changes after admission. • Follow up clinic set up in A&E to monitor progress of symptomatic staff who had not been admitted. • Medical Department divided into clean and dirty teams. • Additional admissions cohorted in 8/F wards; wards re-arranged for triage of cases with suspected or confirmed diagnosis of atypical pneumonia. • Disease Control Center set up in Conference Room 2 (after termination disinfection) to coordinate data collection and reporting. • Meeting with D(PS&PA) and senior staff in Medical Department in the evening to discuss about arrangement of services. • Professor [REDACTED] from HKU invited to join clinical round with Professor Joseph Sung.
13 Mar	<ul style="list-style-type: none"> • Possible index case identified and isolated in 8A. • DH team invited to station in Disease Control Center to facilitate contact tracing.

	<ul style="list-style-type: none"> • Started Cluster Meetings on Atypical Pneumonia (later renamed Cluster SARS Meetings) twice daily to monitor progress and to make decisions on strategies and policies in disease control. • Meeting with WHO and DH team at PWH on outbreak and infection control. • Non-emergency surgical operations, day services and cardiac specialist outpatient clinic suspended. • Diversion of non-atypical pneumonia emergency medical patients attending A&E at PWH to AHNH and NDH. • Infection control guidelines and measures for upgraded droplet infection issued. • Training on infection control started; twice weekly sessions arranged. • First HCE staff forum to communicate with staff on issues related to the atypical pneumonia outbreak.
14 Mar	<ul style="list-style-type: none"> • Index case confirmed with DH. • All clinical admissions in Medicine stopped. • Daily situation reports produced and reported in NTEC Intranet.
15 Mar	<ul style="list-style-type: none"> • First medical staff intubated for ventilation in ICU.
16 Mar	<ul style="list-style-type: none"> • Meeting with PWH Doctors' Association representatives • House Officers from other departments deployed to help the Medical clean team. • Meeting with CE and D(PS&PA) in the evening to discuss possible closure of A&E service or further diversion of medical emergencies.
17 Mar	<ul style="list-style-type: none"> • Daily staff forum started. • Medical emergencies diverted to other hospitals outside NTEC.
18 Mar	<ul style="list-style-type: none"> • Daily morning meeting at HAHO to report on progress of the atypical pneumonia outbreak. • A total of 5 additional medical wards opened for observation and isolation of suspected and confirmed atypical pneumonia patients; rapid increase in the number of ICU cases. • CE joined the Cluster Meeting on Atypical Pneumonia and decided on the closure of the A&E service after reviewing the updated situation. • The use of nebulizer on the index case was identified to be the

	main cause of extensive outbreak in 8A; new guideline on the use of nebulizer issued.
19 Mar	<ul style="list-style-type: none"> • A&E Department closed from midnight onwards for 3 days.
20 Mar	<ul style="list-style-type: none"> • 2 General Practitioners in Shatin and Tai Po admitted. • Meeting with CE to review the evidence on the spread of disease in the community; Dr PY Leung of DH alerted.
21 Mar	<ul style="list-style-type: none"> • Closure of PWH A&E extended for 1 more week.
24 Mar	<ul style="list-style-type: none"> • Chalets at Cheshire Home prepared for admission of SARS patients in convalescence.
26 Mar	<ul style="list-style-type: none"> • Infection control consultation from CDC experts [REDACTED] and [REDACTED]
27 Mar	<ul style="list-style-type: none"> • NTEC SRAS prevention Task Force set up with joint membership from the NTEC Risk Management Team and Infection Control Team.
28 Mar	<ul style="list-style-type: none"> • Completed review on secondary infection of atypical pneumonia among HCW.
29 Mar	<ul style="list-style-type: none"> • First group of 9 staff discharged from hospital.
30 Mar	<ul style="list-style-type: none"> • Re-opening of A&E Department for walk-in cases.
31 Mar	<ul style="list-style-type: none"> • Infection control guidelines updated with stratification of risk levels, use of appropriate PPE and proper gowning and de-gowning procedures.

Epidemiological Curve of PWH Ward 8A SARS Outbreak

