



SARS Outbreak Study 1

Step 1: Learning Objectives

A. Describe the principles of an outbreak investigation:

1. Define an outbreak.
2. Describe an epidemic in terms of person, place and time.
 - Describe what factors are considered in determining whether a person should be classified as suffering from the disease under investigation (case definition).
 - Describe how the choice of case definition can influence the outbreak investigation.
 - List different methods of surveillance used to ascertain cases.
3. List steps in the outbreak investigation.
4. Describe the role of an epidemiologist in the outbreak investigation.

B. Describe the principles of outbreak management

1. List some of the control measures which can be implemented in outbreak management.
2. Describe different methods of outbreak management directed towards various components of the epidemiological triad which consists of host, agent and vector.
3. Describe how the presence or absence of the reservoir influences persistence of the epidemic.
4. Distinguish between eradication and elimination of a disease.

C. Explain the importance of unrestricted flow of information between different public health agencies and timely communication of this information to the public.

Step 2: Introduction to the Study

You have just begun your fall internship at the Epiville Department of Health (DOH) and your supervisor has just asked you to investigate the unusual cases of pneumonia deaths among patients in the Epiville General Hospital, a tertiary care facility. These cases were reported to the DOH through the routine reporting system. All hospitals, physicians and diagnosing laboratories are required to report cases of diseases and conditions indicative of emerging concerns in local public health to the Epiville Department of Health. These reports provide the valuable clinical and demographic data the Department needs for monitoring disease trends and public health intervention.

Step 3: Student Role - Your Plan of Action

You need to gather the following background information found on the various web pages:

- Department of Health
- Epiville Map
- WHO (case definition)
- News report (public radio announcement)

Listen to the WEPI1 news report which provides background to your investigation (text of the newscast is also available).

WEPI1 News Report Transcript

"Good evening. I am Lenny Regression and you are listening to WEPI Channel 1 news. From our Health and Medicine Desk - doctors at the Epiville County Hospital report a suspected outbreak of Severe Acute Respiratory Syndrome.

Since its first appearance in China's Guangdong province in November 2002, SARS has spread so quickly as to alarm global health officials. This spread has been facilitated by world air travel. We spoke with hospital officials who report a steady rise in unusual pneumonia cases over the past two weeks.

We have been told by the hospital administrator who declined to be interviewed that the majority of patients came from area B of Epiville. As of now, 12 persons died from what may turn out to be SARS.

If you experience high fever, cough, difficulty in breathing, and have visited friends or relatives at the Area B within the last two weeks, you may want to see a doctor."

Step 4: Data Collection

Infectious Ward of the Epiville General Hospital

Your next step is to proceed to the Epiville General Hospital. You begin your detective work with the infectious ward of the Epiville General Hospital, the hospital you are investigating at this point, from which the cases were reported to the DOH, by reviewing the charts of patients who died from the mysterious disease. The administrator at the Admissions Office tells you that they suspect that this is severe acute respiratory syndrome (SARS), but the hospital has not yet received the materials to conduct diagnostic tests that could confirm these suspicions.

You decide to create a list with the names of the patients, their symptoms upon admission to the hospital, their duration, and if any of their family members got sick as well. You end up reviewing 12 charts of the patients who seem to have died from the same disease. Six persons were 60 and older, 4 persons were in the age range of 25 to 50, and 2 were children, one 3 year old and one 11 year old.

As you leave the hospital, you are suddenly approached by a news crew, which has camped outside the hospital for the last two days since the rumors about mysterious deaths got out to the community. You decline to comment and insist that you need time to review the available data before making any statements, but this encounter does make you feel important...

Signs and Symptoms Chart	
Symptoms	Percent (%) (N=12)
Fever of 100.4° or More	100
Chills	15
Headache	20
Muscle Aches	45
Dry Cough	75
Shortness of Breath	40
Required a Ventilator	35
Severe Diarrhea	25

As you review the charts, you suddenly realize that many of the patients who died from the disease also happened to have the same street address and lived in the Amoy Apartment Complex. You decide to proceed by going over to their place of residence.

Amoy Apartment Complex

You enter the apartment complex where the twelve fatalities occurred. You arrive at what seems to be the common street address for the 12 fatalities and find yourself in the midst of the apartment complex. Surprisingly, you notice that a large playground and a pretty garden with benches, which surrounds the apartment complex, are completely deserted on this beautiful sunny afternoon. When you find the management office, located within one of the buildings, you realize that the door is locked but the time is only 3:05 in the afternoon. You keep ringing the bell but no one answers.

You finally give up and decide to leave a note where you write the reason of your visit: "Dear Sir or Madam, my name is Jane Woods and I work at the Department of Health. I would like to ask you several questions about some tenants from your apartment complex who got ill over the last 3 weeks and were hospitalized at the Epiville General Hospital. Please let me know what the best time to come by would be." Just as you slip the note under the door and head down to the hall, the door opens and a man's voice with a worried face calls to you. He is apologetic for not having opened the door earlier but pleads that you try to understand why he is behaving like this.

The man is Mr. Jones, one of the managers of the apartment complex. He tells you that one tragedy after another has struck this set of buildings and people of all ages, young and old are coming down with a severe flu and are dying. People are panicking and hardly anybody has left the building over the last three days. He has received 100 phone calls from tenants about breaking rent contracts.

Aside from those persons who already passed away there are 70 other people who came down with similar respiratory flu like symptoms. Most of these individuals were hospitalized at the nearby Epiville General Hospital. Nobody knows what has caused this deadly disease. You find out that there are 200 resident apartments with a total number of 600 residents. You take down the names of these people who reported being affected with similar symptoms.

Before going back to the neighborhood hospital to review the charts of the names you just obtained, you decide to get some caffeine flowing through your system but the deli in the Amoy Apartment Complex is closed.

Step 5: Data Analysis

Back at the DOH:

You suspect that what you have on your hands is an outbreak of SARS in Epiville. An outbreak is defined as the occurrence of more cases of disease than expected in a given area among a specific group of people over a particular period of time. Before going any further with your investigation you need to get guidance from your supervisor. Dr. Zapp outlines the following steps of our outbreak investigation:

1. Establish diagnosis.
2. Define what constitutes a case.
3. Identify cases and obtain information.
4. Collect and analyse descriptive data.
5. Develop hypothesis.
6. Conduct analytical studies to test hypotheses.
7. Conduct special studies.
8. Communicate your findings, including an outbreak report.

You return to your modest cubicle at the DOH and eagerly embark upon the first steps of an outbreak investigation that involve descriptive analysis. Descriptive analysis is concerned with describing the general characteristics of the distribution of a disease. Descriptive studies often provide the first important clues about possible determinants of a disease and are primarily useful for the formulation of hypotheses that can be tested subsequently.

The epidemic should be characterized using the criteria in the case definition. The case definition is the list of specific criteria used to decide whether or not a person has the disease of concern. It is especially important to establish a case definition if the disease is unknown; as is the case with this outbreak. Data collection should not start until the case definition has been established because the case definition determines the data needed in order to classify cases as affected or unaffected.

The case definition is based on:

- a. clinical criteria (signs and symptoms found upon physical examination of cases)
- b. association of cases with Person, Place, and Time (PPT)

PPT associations are an important element of determining if someone is a case of the suspect disease or not. Key questions in determining PPT are:

1. Person: Was the person connected to other suspected cases of the disease?
2. Place: Was the person connected by place to where the other cases came from?
3. Time: Were the symptoms temporarily related to other known cases of the disease?

This means that in addition to having the same clinical signs and symptoms, the affected cases also needed to be connected by PPT.

Now that you have collected symptoms associated with the outbreak of the unknown respiratory illness (suspected to be SARS), your next step is to prepare the case definition.



Intellectually curious?

No case definition will be perfect because there will always be some false positives - those individuals who truly:

- do not have the disease but whose diagnostic test shows that they have the disease and false negatives
- do have the disease but whose diagnostic test shows that they are free of disease.

It is very important to have reliable diagnostic tools to decrease the number of false negatives and false positives. The consequences of misdiagnosing a case and delaying the appropriate treatment, especially in the case of such a deadly infection as SARS can be terrible. For more information on this topic please see Gordis, Chapter 4.

1. Based on what you just have learned about the case definition how would you go about preparing a case definition?

- a. compile a table of symptoms in suspected SARS cases and in patients with other diagnosed respiratory illnesses from the infectious disease ward and provide descriptive epidemiology in terms of PPT
- b. compile a table of symptoms of all patients who were admitted to the hospital during the same time as the first SARS patient was admitted to the Epiville General Hospital
- c. compile a table of patients who were admitted to the Epiville General Hospital over the last year who also lived in the Amoy Apartment Complex

ANSWERS:

A - CORRECT: This answer meets both the clinical criteria of suspected SARS and PPT restriction of the case definition.

B - INCORRECT: This answer does not meet the clinical criteria of suspected SARS case definition but meets the time requirement of the PPT. It does not meet the clinical criteria because, your goal is not to collect all persons who were admitted to the hospital but rather to capture those patients whose symptoms resemble those of SARS and who could be connected to SARS infection via PPT. For example, a child whose family resides in Amoy Apartment Complex and whose father was sick a week earlier during the time when most of the patients were admitted to the hospital.

C - INCORRECT: Here you are ignoring the clinical criteria of the case definition in an attempt to capture the place element of PPT, i.e. everyone who lived in the Amoy Apartment Complex, the place where SARS seems to have emerged

With your case definition at hand, you go back to the Epiville General Hospital to review the charts of the 70 persons

who reside at the Amoy Apartment Complex. Based on your review of the charts, you confirm that 53 out of the 70 suspected cases in the apartment complex are most likely to be SARS cases. Out of the 17 patients who did not meet the case definition 5 had similar symptoms as SARS cases but their chest X-rays were clear, others (6) recovered within a week (this was an indication that they just had flu), and the rest (6) had pneumonia of known etiology. Note that absence of fever is not necessary to rule out SARS diagnosis because often high fever is self-treated with medicines such as Tylenol. All of these 53 individuals are alive and battling the disease.

The case definition you came up with is remarkably similar to the case definition of SARS (see Epiville Department of Health) developed by the World Health Organization (WHO) on the height of the epidemic in the winter-spring of 200 . You decide to use this definition hereafter.

Most of the surveillance that is done on a routine basis is called **passive surveillance** . In passive surveillance, physicians, laboratories, and hospitals are required to report diseases from the list of reportable diseases (usually a list of 70-80 diseases); they are given the appropriate mailing forms and instructions, with the expectation that they will report all of the cases of reportable disease that come to their attention. **Active surveillance** requires periodic telephone calls or personal visits to the reporting individuals/hospitals/laboratories to obtain the required data.

2. Which is the appropriate type of surveillance (passive or active) for each of the following activities describe?

a. Hospitals report SARS cases back to the Department of Health [Check Answer]

b. Your visit to the apartment complex [Check Answer]

ANSWERS:

- A: Passive surveillance
- B: Active surveillance

3. What type of surveillance do you think is more difficult to carry out and why?

a. Passive surveillance

b. Active surveillance

ANSWERS:

- A - INCORRECT: Although it may seem that passive surveillance is more difficult to carry out because you need to get physicians, hospitals, and laboratories to comply with reporting of diseases on routine basis, it is relatively simple for hospitals to set up a system where physicians fill out the necessary reports and submit them to the DOH.
- B - CORRECT: Active surveillance is more difficult to carry out, more labor intensive and costly because DOH has to hire additional staff which will have to make telephone calls and/or visit the medical facilities.

You cannot wait until next morning to show your case definition and report on your visits to the Amoy Apartment Complex to your supervisor. Dr.Morissa Zapp compliments you on your good work and recommends that you contact two other hospitals in the city to see if they have cases of this unknown illness which were not reported through passive surveillance. Your advisor's suspicions are confirmed. There are 3 suspicious deaths in the Star hospital, which should have been reported to the DOH, but were delayed. You set out to do your detective work there.

When you arrive, you notice that the guard is wearing a mask. He tells you that you cannot proceed further without putting on a mask first. You put on your mask and ask where you can find the hospital's administrator. The administrator tells you that they had a 70 year old man admitted two weeks ago with respiratory symptoms, and that a doctor and nurse who were taking care of him got sick within a week of his admission. Both of them had very close contact with the patient and might have come in close contact with the patient's bodily fluids.

When the administration realized how contagious the disease was, the patient was put into isolation and so were the doctor and nurse. Unfortunately, by the time extraordinary precaution measures were instituted to halt the further spread of infection, a large number of staff had fallen ill. However, during that time, 20 more staff members got infected including 5 medical residents. All of them had visited the patient's room while attending the weekly rounds but did not have close physical contact with the patient. The hospital administration notified the DOH by a phone call, but failed to follow-up with proper documents. This small hospital, which serves primarily the community of retirees nearby, was overwhelmed by a shortage of medical staff.

Your intuition tells you to review the chart of the elderly man who was submitted to the hospital and you find out that he too lives in Amoy Apartment Complex but for some reason got admitted to the Star hospital unlike his neighbors. Several days before he got ill, on August 1st 2003, he attended an annual luau party held in the garden of the Amoy Apartment Complex where he resided. Approximately 300 other tenants also attended. .

Now that you have gathered information on all the suspect SARS cases you can proceed with characterizing this epidemic. One of the important steps in accurately characterizing an epidemic involves defining a geographic location of cases. Geographic clustering of cases may give important clues to what is going on. A spot map showing where each affected person lives or works is also helpful in examining an epidemic.

4. Given the place of residence of each SARS affected case:

1. Map distribution of cases, look for clustering [Open Map]
2. Do you see any clustering and where?

a. clustering around the hospital

b. clustering around the Amoy Apartment Complex

c. no clustering

ANSWERS:

A - INCORRECT: While you may anticipate seeing the second clustering around the Star Hospital because there seems to be another suspected SARS outbreak there, you do not because the map is done according to the place of residence. However, although the second outbreak occurred in the Star Hospital the affected personnel live all around the city, aside from the 5 medical residents who live in the housing near the hospital. Note that if you were to do a spot map by place of work, you would have observed clustering around the Star Hospital.

B - CORRECT: You observe clustering only around the Amoy Apartment Complex because most of the cases have the same place of residence. This map confirms a geographic clustering of cases around the apartment complex and that this place of residence is a necessary component of your case definition.

C - INCORRECT: You do observe a clustering of cases as seen by the number of dots around the Amoy Apartment Complex.

The incidence rate is the frequency (number) of events that occur in a defined time period. It is calculated as the number of new cases over a defined study period, divided by population at risk over that period. An incident rate is usually expressed per 100, per 1,000, per 10,000, or per 100,000.

Now that you have mapped out all the cases according to the place of residence, you are ready to do some calculations. Let's calculate incidence for 5 residential areas of Epiville.

Area ^a	Population Size	SARS Cases From the Outbreak at the Amoy Apartment Complex	SARS Cases From the Outbreak at the Star Hospital ^c	Total SARS Cases Reported from 08/03/03 to 08/22/03
A	14,000	0	3	3
B	53,000	66 ^b	4	70
C	13,000	0	5	5
D	12,000	0	8	8
E	8,000	0	2	2

- a - The Amoy Apartment Complex is located in B, the Star Hospital is located in C, the staff of 110 persons who works at the Star Hospital resides all over Epiville and Epiville suburbs.
- b - 65 cases were hospitalized at the Epiville General Hospital and 1 case was hospitalized at the Star Hospital.
- c - 22 cases from the Star hospital include only cases which developed among the staff.

5. In table above, Epiville is divided into 5 residential areas: A, B, C, D, and E.

- a. What is the incidence of SARS (per 1,000) in area A? [\[Check Answer \]](#)
- b. What is the incidence of SARS (per 1,000) in area B? [\[Check Answer \]](#)
- c. What is the incidence of SARS (per 1,000) in area C? [\[Check Answer \]](#)
- d. What is the incidence of SARS (per 1,000) in area D? [\[Check Answer \]](#)
- e. What is the incidence of SARS (per 1,000) in area E? [\[Check Answer \]](#)

ANSWERS:

A: $(3/14,000) \times 1,000 = 0.21$ per 1,000 over a two-week period. *

* Please note that a specified period of time is a critical element in calculating incidence.

B: $(70/53,000) \times 1,000 = 1.32$ per 1,000 over a two-week period.

C: $(5/13,000) \times 1,000 = 0.38$ per 1,000 over a two-week period.

D: $(8/12,000) \times 1,000 = 0.67$ per 1,000 over a two-week period.

E: $(2/8,000) \times 1,000 = 0.25$ per 1,000 over a two-week period.

6. In which area do you observe the highest incidence of SARS? Why?
- a. Area D because the largest number of Star hospital employees resides here
 - b. Area B because it has the largest population
 - c. Area B because this is where the Amoy Apartment Complex is located and where the largest number of new cases live.

ANSWERS:

A: INCORRECT: While it is true that the greatest number of Star personnel reside in Area D, it does not have the greatest number of SARS cases, only the greatest number of SARS cases who got ill at the Stars Hospital. Therefore, it does not have the highest incidence rate.

B - INCORRECT: Area B has the largest population, which is indicative of the greater number of persons at risk. However, incidence is defined as the number of new cases divided by the number of persons at risk during a specified time period. Therefore, knowing the number of persons at risk is not enough to conclude that the incidence rate is highest in area B

C - CORRECT: Incidence rate is a function of both the number of new cases and the number of people at risk. Therefore, you will get the greatest incidence rate when your numerator (number of new cases) is large and/or when the denominator is small (the number of people at risk). Since the greatest number of cases happens to have occurred in the Amoy Apartment Complex that is located in Area B, the incidence rate is highest in this area as well (1.32 per 1000 per 3-week period).

Modes of disease transmission can either be direct or indirect (Gordis, p. 15). A disease can be transmitted from person to person by means of direct contact (this is what typically happens during the flu season). Indirect transmission usually occurs through a common vehicle such as contaminated water supply or air or by a vector such as mosquito (for instance, West Nile encephalitis).



Intellectually curious? More on Transmission

Common vehicle transmission refers to a single inanimate vehicle that serves to transmit the infection to multiple hosts. The most commonly involved vehicles are food and water. **Airborne transmission** refers to airborne infected particles, which are spread by droplet nuclei or dust. **Vector-borne transmission** refers to transmission by insects that may carry organisms on their surface or ingest them.

7. Based on the cases from the Amoy Apartment Complex, which mode of transmission is most probable? (Refer to Gordis, p.15 for more information to help you answer this question.)
- a. common source: food or water.
 - b. airborne
 - c. vector-borne: cockroaches
 - d. direct: person-to-person

ANSWERS:

A - INCORRECT: Symptoms of the disease are not indicative of the food or water poisoning and of intestinal disease. In addition, if this disease were transmitted via food and water, then we would anticipate that all would had fallen ill subsequently to their outing.

- B - INCORRECT: If this were an airborne organism that was efficiently transmitted in an airborne fashion, we may expect to see many more cases of SARS than we saw here.
- C - INCORRECT: Only 66 persons from the 600 residing at the Amoy Apartment Complex fell ill with SARS. It is unlikely that these 66 persons all came in contact with cockroaches within such a short time period unless the apartment complex was really infested, which was not the case.
- D - CORRECT: All cases occurred close in time which means that this is a common source epidemic. All of the cases have attended the party where they were in close contact with each other for several hours.

8. Based on the cases from the Star hospital which mode of transmission is most probable?

a. Only via bodily-fluids (hint: this is one type of direct transmission)

b. airborne

c. Direct: person-to-person

ANSWERS:

A - INCORRECT: While it is possible that the nurse and the doctor who took care of the index patient at the Star hospital got infected by touching the patient, it fails to explain why other 20 medical personnel, who did not come into such close contact, got sick.

B - INCORRECT: The index case was hospitalized in the regular inpatient ward. If the disease was airborne, it would have quickly spread around the hospital through the building's common air shafts.

C - CORRECT: All cases occurred close in time which means that this is a common source epidemic. In addition, no other cases of unknown respiratory illness occurred at the hospital.

Step 6: Plan of Action

Just as you are going over your descriptive analysis, Dr. Zapp calls you in your office to let you know that SARS diagnosis has been confirmed for all 12 dead cases from the Amoy Apartment Complex. Your primary goal now is to plan an effective outbreak management.

Outbreak management is the process of anticipating, preventing, preparing for, detecting, responding and controlling outbreaks in order to minimize their health and economic impact. During the outbreak management it may be necessary to take the following measures: quarantine (isolate a person until he or she is no longer infectious, based on the disease definition), isolation of contacts, and surveillance (passive and active).



Intellectually curious? Use of Laboratory Methods for SARS Diagnosis

Recommendations on interpretation of laboratory results: Positive SARS diagnostic test findings

- a. Confirmed positive PCR for SARS virus
 at least 2 different clinical specimens (eg nasopharyngeal and stool)
 OR
 the same clinical specimen collected on 2 or more days during the course of the illness (eg 2 or more nasopharyngeal aspirates)
 OR
 2 different assays or repeat PCR using the original clinical sample on each occasion of testing
- b. Seroconversion by ELISA or IFA
 negative antibody test on acute serum followed by positive antibody test on convalescent serum
 OR

four-fold or greater rise in antibody titre between acute and convalescent phase sera tested in parallel

c. Virus isolation

Isolation in cell culture of SARS-CoV from any specimen; plus PCR confirmation using a validated method.

Confirmation of positive PCR

- The PCR procedure should include appropriate negative and positive controls in each run, which should yield the expected results:
- 1 negative control for the extraction procedure and 1 water control for the PCR run
- 1 positive control for extraction and PCR run
- the patient sample spiked with a weak positive control to detect PCR inhibitory substances (inhibition control)
- If a positive PCR result has been obtained, it should be confirmed by:
- repeating the PCR using the original sample
OR
- having the same sample tested in a second laboratory.

Amplifying a second genome region could further increase test specificity

Recommendations for laboratories testing for SARS

Reference laboratories should be identified at national level.

Antibody testing

ELISA and IFA tests are being developed by research laboratories. Because SARS a new disease in humans, SARS-CoV antibodies are not found in populations that have not been exposed to the virus. An antibody rise between acute and convalescent phase sera tested in parallel is very specific.

9. What do you think will be appropriate measure to control these two outbreaks given what we know about SARS so far?

a. Isolation and quarantine

b. Educate the population on how to avoid infection

ANSWERS:

A - CORRECT: We want to isolate an infected person until he or she is no longer infectious and we want to quarantine those who have been exposed and may be infected but are not yet ill. Separating exposed people and restricting their movements is intended to stop the spread of the infection. Quarantine is medically very effective in protecting the public from disease.

B - INCORRECT: While this is a necessary precaution for those individuals who may potentially come into contact with diseased individuals and public awareness alone would not be sufficient to directly address the two outbreaks in question.

Step 7: Discussion Questions

1. Based on what you know about HIV and SARS, how is SARS different from HIV?
(hint: consider the following bullet points to compare these 2 epidemics)
 - time to diagnosis of each disease from its emergence
 - resources
 - involvement of global community
2. What do you think you should do with your findings at the end of the outbreak investigation?
(hint: think of how you want to communicate your findings to the public).
3. How would the knowledge of the natural reservoir influence your proposed outbreak control measures?
(hint: reservoir is any person, animal, arthropod, plant, soil or substance (or combination of these) in which an infectious agent normally lives and multiplies)

Questions for the Intellectually Curious

1. Based on what you know about SARS, what do you think is most probable, eradication or elimination of SARS? (hint: elimination is reduction of the incidence of infection (disease) caused by a specific agent below detectable levels in a defined geographic area and eradication is the permanent reduction to zero of the worldwide incidence of infection caused by a specific agent so that no transmission occurs in nature).
2. Why is unrestricted flow of information between different public health agencies important? What are the implications of the delay in flow of information between different agencies?



Intellectually curious? Article: Stigmatization of SARS

(The New York Times - June 4, 2003)

And Now, SARS' Emotional Toll By KEITH BRADSHER

HONG KONG, June 3 - The pace of new SARS infections is ebbing in East Asia, but the disease now appears to be taking a greater emotional toll than initially recognized, both on people infected and on the many more people who face discrimination because of their association with SARS victims.

A new study by psychiatrists here has found that 45 percent of a group of 150 patients who have recovered from SARS, or severe acute respiratory syndrome, had psychiatric problems when they were discharged. The Hong Kong Equal Opportunities Commission has also received dozens of complaints from people who said they lost their jobs or encountered other problems because their employers feared they were at high risk of contracting the disease.

The psychiatrists and the commission say a big part of the problem lies in the stigma attached to people who have had the disease or have had any contact with it. Recovered patients as well as doctors and nurses who cared for them, and even the neighbors of SARS patients, have been widely shunned, sometimes by their own families.

SARS-related discrimination has also been a problem in Singapore, Taiwan, Vietnam and mainland China, which have also experienced large outbreaks of SARS this spring.

During a televised news conference today, Dr. Margaret Chan, Hong Kong's director of health, urged the public to show more compassion. She warned that discrimination could discourage possible future SARS sufferers from seeking medical attention in time.

"We would like to appeal to you for ensuring patients who have suffered from SARS should be respected and treated with dignity," she said.

The stigma has been a serious problem for Victoria Ng, who has never contracted the disease. Her family, friends and co-workers have nonetheless shunned her because she lives at Amoy Gardens, the 19-building apartment complex here where 329 of the 17,000 residents came down with the illness in March and April. The disease has killed 42 of those infected.

Ms. Ng, 30, lives by herself in a small apartment decorated with dozens of Hello Kitty dolls, and with doors that she painted pink herself. Only one person in Ms. Ng's building ever contracted SARS, a Health Department official said, and Ms. Ng said that was someone who had moved from Block E - where most of the infected people lived - to her building just before falling ill.

Yet such is the fear of SARS here that Ms. Ng's eight brothers and sisters and her only living parent, her mother, have refused to see her at Amoy Gardens or anywhere else for the last two months. Her friends have refused to go out with her, her employer requires her to wear two layers of masks at work, and her co-workers keep their distance, she said.

Ms. Ng said that one brother-in-law, a police officer, even rolled up his windows while driving past Amoy Gardens. "They still don't want to see me," she said, adding that the isolation had been so painful that she had suffered bouts of sudden weeping and had begun taking prescription antidepressants for the first time.

People who have actually contracted SARS and then recovered appear to be at especially high risk of developing psychiatric problems, said Dr. Wing Yun-kwok, an associate professor of psychiatry at Chinese University who worked on the new study, for which 150 recovered patients were interviewed at length when they were discharged.

Those patients had an extremely low rate of mental illness before they fell sick with SARS, possibly because 70 percent of them were health care workers. The rate of psychiatric problems is likely to be even higher for SARS cases in the general population than the 45 percent found in the study, Dr. Wing said.

Discharged patients with psychiatric troubles suffered from anxiety, depression or posttraumatic stress, Dr. Wing said. In "about 5" of the 150 cases, the patients actually experienced psychotic or manic episodes, possibly as a result of the very high doses of steroids with which they had been treated.

The study, which is still being prepared for publication, attributed the psychiatric problems to the "four S's": SARS, steroids, stress and stigma.

Dr. Wing said that there had been no clear evidence yet that the SARS virus directly attacks the brain. But Dr. Malik Peiris, a Hong Kong University microbiologist not involved in the psychiatry study, cautioned that autopsies of SARS patients have mostly been conducted with little attention to the brain.

Anna Wu, the chairperson of the Hong Kong Equal Opportunities Commission, said her agency had been receiving complaints of sometimes outrageous discrimination against people with any connection to SARS. In one case, a woman was dismissed for refusing to write and sign a pledge not to see her boyfriend, a male nurse who has been treating SARS patients, Ms. Wu said.

The woman has since received a small sum of money and an apology from her former employer, but has decided to look for a new job, Ms. Wu said.

No business has questioned the commission's stance that people with SARS or associated with the disease, like health workers, are protected by Hong Kong's antidiscrimination statutes, Ms. Wu said. Some businesses have maintained instead that their dismissals were prompted by Hong Kong's present economic troubles, and not by discrimination.

The commission has received 38 SARS-related complaints seeking "fast track" handling, 34 of which have been resolved. There have been 22 SARS-related complaints seeking more extensive investigations, only 3 of which have been settled. Settlements here are small by American standards: a pregnancy discrimination case on May 23 produced a \$19,870 court verdict that was among the largest the agency has won for an individual.

American government officials have been warning that SARS, following the pattern of many respiratory diseases, may return next winter and become more of a global problem then. But for now, there are a few signs here that as new cases of the disease are fewer, reactions to the disease may become more measured.

Tsang Kam-on, a 45-year-old dim sum chef, lives in Block E of Amoy Gardens with his wife and 3-year-old daughter, occupying a tiny apartment where clothing hangs even in the living room above the bright blue plastic sofa. Mr. Tsang said that his friends and relatives had been willing to visit him, and some had taken the building's cramped, steel-walled elevators to visit him in his home, even though it is situated at the center of Hong Kong's worst single-building outbreak.

Mr. Tsang lost his job before the SARS outbreak and has been unable to find another one since, but he does not blame discrimination. "There are no job vacancies anyway," he said. "Many restaurants have closed down."

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