Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company’s public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
A loophole in international quarantine procedures disclosed during the SARS crisis

Chi-Wei Lee,*, Yen-Shuo Tsai, Tai-Wai Wong, Chor-Chiu Lau

The Graduate Institute of Clinical Medical Sciences of the Chang Gung University, Taiwan
Emergency Department of the E-Da Hospital, Taiwan
A&E Department of the Pamela Youde Nethersole Eastern Hospital, Hong Kong

Received 1 April 2004; received in revised form 4 October 2004; accepted 14 October 2004
Available online 30 December 2004

KEYWORDS
Loophole; Quarantine; Medical fees; Multi-country outbreak

Summary This study describes a loophole in the international quarantine system during the recent Asian severe acute respiratory syndrome (SARS) outbreak. Specifically, that of travelers disguising symptoms of respiratory tract infection at international airports, in order to board aircraft to return to their home countries—notwithstanding the infection risks this involves to others. High medical fees for treatment to non-residents in epidemic areas were found to be the main cause for this behaviour. This phenomenon revealed a loophole in the control mechanisms of international quarantine procedures, letting travelers carrying a highly contagious virus slip by undetected and causing possible multi-country outbreaks of communicable diseases. Clinical evidence collected from medical records at medical centers can highlight this oversight.

© 2004 Elsevier Ltd. All rights reserved.

Introduction

From November 2002 onwards, the severe acute respiratory syndrome (SARS) had spread rapidly via international air travel to at least 30 countries. As of December 31, 2003, reported cases had numbered 8096 with 774 deaths. Reasons for its rapid global spread were the highly contagious nature of the virus with its air-borne route of infection, the busy links between affected countries, and probably inadequacies in international quarantine procedures. The increasing volume of international tourism and trade has raised the risks for translocation of exotic diseases. In other words, the increased mobility, mixing and congregation of civilian populations from different nations increase the rate of transmissible diseases. Countries need to cooperate more closely in the future, not only on finding the causes and the management of epidemic outbreaks, but also on preventing the further spread of them. For example, SARS had affected people in many areas: in Canada (Toronto); in China (Guangdong, Hong Kong, Shanxi, Beijing); in Taiwan; in Singapore; and in Vietnam (Hanoi). On March 12, 2003, the World Health Organization (WHO) issued a global alert,
recommending that national authorities implement heightened surveillance for cases of SARS. Recommendations were aimed at limiting the spread of SARS and protecting international air passengers. The screening measures for potential SARS symptoms instituted by national health officials and port authorities, included interviews with passengers, as well as the taking of tympanic core body temperatures from boarding and disembarking passengers by way of electronic thermometers and infra-red cameras. National authorities also advised travelers with fever to postpone international travel from SARS documented areas. International travelers were educated through the public media on the symptoms of SARS and were advised to seek immediate medical attention should such symptoms occur. According to the WHO report, evidence had indicated that since the start of SARS global surveillance at the end of February 2003, a number of suspected and probable cases of SARS had departed from affected countries on flights to other countries (http://www.who.int/csr/sars/archive/2003_04_11/en/). Local transmission could conceivably have occurred inside the cabin of an aircraft to persons seated close to a SARS infected person, by way of droplets discharged through coughs or sneezes. In total, 26 nations (27 administrative independent regions, including Hong Kong) were reported up to April 2003, to be infected by the SARS epidemic, in part a consequence of international travel. In fact, the international traveler is an efficient vector for SARS as well as new respiratory pathogens yet to emerge.\(^4\) The aim of this study is to describe reasons for a loophole in international quarantine procedures.

**Results**

The investigation revealed that during this period a total of 46 passengers were symptomatic during transit on board aircraft, meaning that at least 2 and at most 9 passengers per day were found to be symptomatic during their flight. Since the flying time from Hong Kong to Kaohsiung is only 45 to 60 minutes, it is reasonable to suspect that symptomatic passengers were actually aware of their symptoms before boarding the aircraft. Thus they fully understood that they were possibly infected with the SARS virus when departing from an endemic area and before heading for Taiwan, despite the aggressive screening procedures put in place by the Hong Kong Customs and Department of Health at Hong Kong’s International Airport. In order to explain the circumstances for this observed phenomenon and the underlying reasons for such behavior, we proceeded to the second part of our study.

Here, six patients visiting the emergency department of E-Da Hospital, from March 19 to 22, 2003, were found to show symptoms from respiratory tract infections, after they had departed from a SARS endemic area and had entered the territory of Taiwan by air. As shown in Tables 1 and 2, although none of the six patients were eventually diagnosed wild SARS, this observed phenomenon disclosed a very important loophole in the control aspect of international quarantine procedures: the inability to prevent persons with a highly contagious virus from slipping past undetected and thus preventing the further spread of epidemics like SARS on international travel routes. All of these patients admitted that extraordinarily high medical fees for non-residents in Hong Kong, was the major reason for them to hurry back to Taiwan, where the cost medical care is significantly lower.

**Method**

This study was divided into two parts: information was collected at the international airport of Kaohsiung (Taiwan), on the physical conditions of passengers who flew from Hong Kong and landed at Kaohsiung from April 10 to 22, 2003. This information was compiled from questionnaires and brief interviews of arriving passengers. In addition, information was gathered from body temperature measurements performed on each arriving passenger who entered Taiwan. Records from at the Emergency Department of E-Da Hospital, in Southern Taiwan, of patients suffering from symptoms of respiratory tract infection who had departed recently from SARS areas from March 19, 2003 onwards were analyzed.

**Discussion**

In this study, we identified that there were loopholes in the international quarantine system for controlling the international spread of contagious disease like SARS, especially when travelers lack a strong motivation to cooperate with national health authorities. This arises particularly when the high medical fees are imposed on non-local residents in endemic areas, were a significant financial burden. Furthermore, the emergency room’s medical records showed that patients were already aware of their symptoms such as cough or indications of high fever (though not necessarily SARS) before they boarded their respective flights. Nevertheless,
they denied being sick before departure when questioned by health authorities, in full awareness of the infection risks, in order to reach Taiwan. Since Taiwanese residents benefit from very low medical fees in their health care system, in contrast to Hong Kong's high hospital fees for non-residents. Taiwan's medical fees are only $3.585 (NT$150) per attendance in the emergency room and just 10% of the total medical expense during the course of admission for in-patient care at a district hospital, with the remaining cost being subsidized by the national health care plan (See Table 3). Tables 4 and 5 show a strong correlation in different medical fees for residents and non-residents both in Hong Kong and Singapore. For example, the admission fee for in-patient care (general acute beds) is $10.4 (HK$100) per day in Hong Kong for residents or Hong Kong identity card holders, while a non-Hong Kong resident has to pay $343.2 (HK$3,300) per day for the same treatment—33 times higher. In comparison, all Taiwan nationals and residents are covered under the policy of the national health care insurance plan, and thus pay less than $11.95 (NT$500) per day for in-patient care. This cost differentiation for residents and non-residents in Hong Kong, is a phenomenon observed almost in every country in the world, with similar examples existing among different member countries in the

| Date (month/day) | Time of arrival | Departure from | Number of passengers on board | Number of symptomatic passengers | Tympanic body temperature > 37.5°C | Remarks |
|-----------------|----------------|----------------|-------------------------------|----------------------------------|----------------------------------|---------|
| 4/10            | 20:18          | HK             | 60                            | 2                                | 0                                | Cough   |
| 4/11            | 14:15          | HK             | 97                            | 3                                | 0                                | Cough   |
| 4/11            | 23:15          | HK             | 64                            | 1                                | 0                                | Cough   |
| 4/12            | 13:39          | HK             | 93                            | 2                                | 0                                | Cough   |
| 4/12            | 14:18          | HK             | 139                           | 2                                | 0                                | Cough   |
| 4/12            | 16:24          | HK             | 155                           | 2                                | 0                                | Cough   |
| 4/12            | 21:14          | HK             | 51                            | 1                                | 0                                | Cough   |
| 4/13            | 11:22          | HK             | 52                            | 1                                | 0                                | Cough   |
| 4/13            | 13:54          | HK             | 125                           | 1                                | 0                                | Cough   |
| 4/13            | 16:20          | HK             | 95                            | 2                                | 0                                | Cough   |
| 4/13            | 22:51          | HK             | 55                            | 1                                | 0                                | Sorethroat cough |
| 4/14            | 14:00          | HK             | 91                            | 2                                | 0                                | Cough   |
| 4/14            | 16:25          | HK             | 85                            | 4                                | 0                                | Cough   |
| 4/15            | 14:15          | HK             | 103                           | 1                                | 0                                | Cough   |
| 4/15            | 21:14          | HK             | 46                            | 1                                | 0                                | Cough   |
| 4/16            | 11:49          | HK             | 117                           | 1                                | 0                                | Cough   |
| 4/16            | 14:02          | HK             | 137                           | 0                                | 2                                | Fever   |
| 4/16            | 16:12          | HK             | 123                           | 2                                | 0                                | Cough   |
| 4/16            | 22:45          | HK             | 56                            | 1                                | 0                                | Cough   |
| 4/18            | 11:37          | HK             | 206                           | 2                                | 0                                | Cough   |
| 4/18            | 16:12          | HK             | 151                           | 1                                | 0                                | Cough   |
| 4/18            | 21:10          | HK             | 137                           | 3                                | 0                                | Cough   |
| 4/18            | 22:58          | HK             | 97                            | 2                                | 0                                | Cough   |
| 4/19            | 14:00          | HK             | 106                           | 1                                | 0                                | Cough   |
| 4/20            | 11:35          | HK             | 35                            | 1                                | 0                                | Cough   |
| 4/20            | 16:10          | HK             | 108                           | 1                                | 0                                | Cough   |
| 4/20            | 21:00          | HK             | 62                            | 1                                | 0                                | Cough   |
| 4/20            | 22:46          | HK             | 39                            | 1                                | 0                                | Cough   |
| 4/21            | 13:52          | HK             | 54                            | 1                                | 0                                | Cough   |
| 4/22            | 21:08          | HK             | 80                            | 2                                | 1                                | Cough, fever |
Table 2  Summarized data from chart records of patients who visited the emergency department since the beginning of March 2003.

| Patients | Age | Sex | Time of onset of symptoms | Time of departure from the endemic area and time of arrival at Taiwan | Date of visit to the emergency room | Lab data of white blood cell count | Chest X-ray findings | Final diagnosis |
|----------|-----|-----|---------------------------|-------------------------------------------------|----------------------------------|---------------------------------|-------------------------------|-------------------|
| A        | 50  | F   | Cough, fever (38 °C), sorethroat since March 17th | From Guangzhou to Hong Kong on March 18th | March 19th | WBC: 5700/cm³  Segment: 71.8%  Lymphocyte: 18.2% | Consolidation in right lower lobe and left lower lobe of lungs | Atypical pneumonia |
| B        | 78  | M   | Cough, dyspnea, fever (38 °C) since March 17th | From Mainland China to Hong Kong on April 1st | April 3rd | WBC: 21100/cm³  Segment: 82%  Lymphocyte: 9% | Consolidation in right middle lobe of lung | Chronic obstructive pulmonary disease with secondary infection |
| C        | 36  | F   | Dyspnea, myalgia, sorethroat, fever (38.8 °C) since March 30th | From Australia to Hong Kong on March 31st | April 2nd | WBC: 6100/cm³  Segment: 77.7%  Lymphocyte: 14.1% | No definite active lung lesion | Atypical pneumonia |
| D        | 3   | M   | Cough, rhinorrhea, vomiting, anorexia, fever (39 °C) since April 6th morning | From Guangzhou to Hong Kong on April 6th | April 6th | WBC: 17100/cm³  Segment: 91.7%  Lymphocyte: 5.2% | Mild infiltration over bilateral lower lung fields and perihilar region | Bronchopneumonia |
| E        | 26  | F   | Fever (39.4 °C) since March 21st morning | From Vietnam to Taiwan on March 21st | April 22nd | WBC: 5700/cm³  Segment: 60.4%  Lymphocyte: 24.7% | No definite active lung lesion | Atypical pneumonia |
| F        | 31  | F   | Cough with sputum, fever (38 °C) since April 11th | April 19th from Vietnam to Taiwan | April 21st | WBC: 4000/cm³  Segment: 70.7%  Lymphocyte: 29.3% | No definite active pulmonary lesion | Atypical pneumonia |

Patients admitted that they were symptomatic before their departure from epidemic areas of SARS.
European Union. This is only a natural human response for a symptomatic traveler to disguise his/her illness at their point of departure, to flee back to his/her home country for medical care at a significantly lower cost. However, this apparent trivial aspect of human behavior turns out to be a very serious problem in terms of epidemics and quarantine control measurements, where communicable diseases could be introduced into a population by the arrival of outside foreign infectives. Citing the example discussed here, the possibility exists that travelers may return home from a foreign trip with an infection acquired abroad. While an experimental model indicates that screening and quarantining of infectives can considerably reduce the infective equilibrium.

The egocentric human behavior of certain travelers who break quarantine rules, could be modified by better cooperation between governments. In today's highly mobile society, it is crucial to deter international travelers from spreading contagious diseases during an epidemic and lessons may be learned from the worldwide spread of SARS so that precautions can be taken in the policy-making process for the future since a similar tragedy may repeat itself anytime, anywhere in the world. In response to the main issue identified in this report, governments need to set sensible medical fees for

---

**Table 3** Co-payment requirement of medical fees for National Health Insurance (NHI) holders versus full-payment requirement of medical fees non-holders in Taiwan. (NT$: New Taiwan Dollar).

| Service                        | Fees for non-NHI holders                                      | Fees for NHI-holders                                      |
|--------------------------------|---------------------------------------------------------------|----------------------------------------------------------|
| Emergency Care (district hospitals) | Entirely depends on the type and amount of medical resources consumed | €3.585 (NT$150) per attendance                           |
| In-Patient Care (district hospitals) | Entirely depends on the type and amount of medical resources consumed | 10% of the total medical expense during the course of admission |

Conversion of Currencies: NTS1 (New Taiwan Dollar) = €0.0239 (Euro); HK$1 (Hong Kong Dollar) = €0.1040 (Euro); S$1 (Singapore Dollar) = €0.4754 (Euro).

---

**Table 4** Fees introduced on 1 April 2003 by the Hospital Authority of Hong Kong.

| Service                                    | Fees for non-eligible persons | Fees for eligible persons |
|--------------------------------------------|--------------------------------|---------------------------|
| Accident and emergency                     | £5.2 (HK$570) per attendance  | €10.4 (HK$100) per attendance |
| In-patient (general hospitals)             | £343.2 (HK$3,300) per day     | €5.2 (HK$550) admission fee for the 1st day, €10.4 (HK$100) per day |
| In-patient (psychiatric hospitals)         | £124.8 (HK$1,200) per day     | €7.072 (HK$68) per day    |
| Special intensive care ward/unit           | £1882.4 (HK$18,100) per day   | €5.2 (HK$550) admission fee for the 1st day, €10.4 (HK$100) per day |
| Intensive care ward/unit                   | £1445.6 (HK$13,900) per day   | €5.2 (HK$550) admission fee for the 1st day, €10.4 (HK$100) per day |
| High dependency ward/unit                  | £1019.2 (HK$9,800) per day    | €5.2 (HK$550) admission fee for the 1st day, €10.4 (HK$100) per day |
| Nursery                                    | £66.56 (HK$640) per day       | €10.4 (HK$100) for the 1st attendance, €6.24 (HK$60) per attendance, €1.04 (HK$10) per drug item |
| Specialist out-patient (including allied health services) | £72.8 (HK$700) per attendance |                            |
| General out-patient                        | £22.36 (HK$215) per attendance | €4.68 (HK$45) per attendance |
| Dressing and Injection                     | £7.28 (HK$70) per attendance  | €1.768 (HK$17) per attendance |
| Geriatric and Rehabilitation day hospital  | £145.6 (HK$1,400) per attendance | €5.72 (HK$55) per attendance |
| Psychiatric day hospital                   | £91.52 (HK$880) per attendance | €5.72 (HK$55) per attendance |
| Community nursing (general)                | £35.36 (HK$340) per visit     | €8.32 (HK$80) per visit   |
| Community nursing (psychiatric)            | £109.2 (HK$1,050) per visit   | Free                      |
| Community allied health services (general and psychiatric) | £109.2 (HK$1,050) per treatment | €6.656 (HK$64) per treatment (general) free (psychiatric) |

Fees and charges for non-eligible versus eligible persons. Eligible Persons of public health services are holders of Hong Kong Identity Card issued under the Registration of Persons Ordinance and their children who are under 11 years of age. ($: Hong Kong Dollar). Services are charged as per Gazette.
the temporary hospitalization of ‘aliens’ staying in their territories during periods of epidemic outbreaks. This cost could be shared by governments across the globe, with coordination by the WHO, so as to enforce quarantine measurements more efficiently. The existing cross-border care and international payment coverage policy within the European Union can be seen as a good reference base for constructing such a cross-linking system to tackle this emergent problem of international quarantine. The measure may stop people from becoming disease-vectors within their home countries and also to other passengers on the same plane who may carry infection to many different destinations all over the world. Thus, it is of importance, that governments in endemic areas publicize such policies, targeting foreigners staying within their boundaries during an outbreak. It is estimated that the sum of inter-governmental medical expenses incurred by infective or potential infective patients hospitalized at sensible cost in the ‘host countries’, would be substantially lower than the total social costs caused by the spread of communicable diseases, if these infectives were allowed to return to their mother countries. Thus, the aim of future research should be focused on the health and safety investment as well as risk control methods.

Foreigners in Singapore and those who are on long-term social visit passes will have to pay more for treatment at the government or government-restructured hospitals. They can only stay in Class A and B1 wards. If they would like to stay in Class B2 or C wards, the charges will double. (S$: Singapore Dollar).

| Ward/class | Government hospitals | Restructured hospitals |
|------------|----------------------|------------------------|
| A1 (Single bed) | ₹114.096 (S$240) | ₹97.9324 (S$206) to ₹153.5542 (S$323) |
| A2 (Two-bedded) | ₹92.703 (S$195) | ₹95.08 (S$200) to ₹102.211 (S$215) |
| B1 (Aircon four-bedded) | ₹71.31 (S$150) | ₹68.933 (S$145) to ₹89.8506 (S$189) |
| B1 (Non-aircon four-bedded) | ₹54.671 (S$115) | - |
| B2 (Six to 12 beds) | ₹19.016 (S$40) | ₹18.5406 (S$39) to ₹23.77 (S$50) |
| C (Open ward) | ₹9.9834 (S$21) | ₹9.508 (S$20) to ₹11.885 (S$25) |

Table 5  Current medical fees of government hospitals and restructured hospital for local citizens versus foreigners in Singapore (year 2003).
that should the next pandemic be caused by a virus as deadly as that of 1918 influenza pandemic, the potential for disaster would be greater than ever.\textsuperscript{11} As the world’s population is now more than three times greater than it was in 1918, with nearly half that population residing in urban areas, including hundreds of millions crowded into slums and shanty towns in the developing world. Faced with today’s highly mobile transportation links, a virulent virus could easily spread around the world in a matter of days. Another pandemic would challenge the world’s public-health resources as never before. Therefore, an effective response to future pandemics of viral infection proportions, such as the 1918 Influenza Pandemic, will demand the full support and complete cooperation of the public.\textsuperscript{11} Yet the global health community is not prepared for the next viral pandemic, according to Klaus Stöhr (WHO, Geneva, Switzerland), speaking at the International Congress on Infectious Diseases (Singapore, March 11-14, 2002).\textsuperscript{12} Furthermore, mankind’s history and this case study provides evidence that travelers have contributed significantly to the rapid spread of AIDS\textsuperscript{13,14} and SARS, therefore strict international quarantine enforcement, must be considered for future epidemics. Only then, would we be ready to confront similar or even tougher challenges of pandemic outbreaks. In fact, bilateral, as well as regional agreements among different governments on visitors’ health care are becoming more common. For example, an extensive list of countries has reciprocal health care agreements with the United Kingdom.\textsuperscript{16}

Other non-economic reasons for return home of febrile passengers during the SARS epidemic include fear for being infected in the epidemic region, reluctance to be isolated in a foreign country, unfamiliarity with foreign culture, planned travel schedule, etcetera. Nevertheless, according to the record of the medical history taken in our emergency department, all six patients admitted that the big gap between medical costs in a foreign country and their mother country was the main reason for disguising their fever on departure. In contrast to sea-voyage, air travel journey is relatively short in duration. Infected crew or passengers who travel on board ships would have their diseased status shown clearly during the long sea-voyage, and would have died or being quarantined when they arrived at their destined port. However, due to the relatively short duration of air-travel, the clinical condition of infected passengers on board airplane would not have sufficient time to progress to a serious stage which is obvious enough to detected by the custom at the destined airport. Here lies the loophole of international quarantine which would be easily overlooked by airport custom, but not sea-port custom. Thus, emergency departments or walk-in-clinics are playing the important role in safeguarding the community from imported infectious diseases. Emergency physicians should maintain a high level of awareness regarding potential outbreaks of infectious diseases of any kind and play a role in alerting public health authorities to any loopholes in quarantine procedures.

References

1. Sutherst RW. The vulnerability of animal and human health to parasites under global change. \textit{Int J Parasitol} 2001;31:933-48.
2. Smallman-Raynor M, Clift AD. The Philippines' influenza pandemic and the 1902-4 cholera epidemic: Part I—Epidemiological diffusion processes in war. \textit{J Hist Geogr} 1998;24:69-89.
3. Smallman-Raynor M, Clift AD. The Philippines' influenza pandemic and the 1902-4 cholera epidemic: Part II—Diffusion patterns in war and peace. \textit{J Hist Geogr} 1998;24:188-210.
4. Freedman D. SARS—lessons learned so far. \textit{Travel Med Infect Dis} 2003;1:67-8.
5. Sheaff R. Healthcare access and mobility between the UK and other European Union states: an ‘implementation surplus’. \textit{Health Policy} 1997;42:239-53.
6. Brauer F, Van den Driessche P. Models for transmission of disease with immigration of infectives. \textit{Math Biosci} 2001;171:143-54.
7. Brouwer W, Van Exel J, Hermans B, Stoop A. Should I stay or should I go? Waiting lists and cross-border care in the Netherlands \textit{Health Policy} 2003;63:289-98.
8. Niven KJM. A review of the application of health economics to health and safety in healthcare. \textit{Health Policy} 2002;61:291-304.
9. Hethcote H, Ma Z, Liao S. Effects of quarantine in six endemic models for infectious diseases. \textit{Math Biosci} 2002;180:141-60.
10. Gensheimer KF, Strikas RA, Fukuda K, Cox NJ, Sewell CM, Dembek ZF, Myers M. Influenza pandemic planning: review of a collaborative state and national process. \textit{Int Congress Series} 2001;1219:733-6.
11. Epidemic and pandemic “flu. Editorial. \textit{The Lancet} 2000;355:509.
12. McConnell J. Ready for the next influenza pandemic? \textit{The Lancet} 2002;359:1133.
13. Ada G. HIV and pandemic influenza virus: two great infectious disease challenges. \textit{Virology} 2000;268:227-30.
14. Perrin L, Kaiser L, Yerly S. Travel and the spread of HIV-1 genetic variants. \textit{The Lancet} 2003;22:7.
15. Oshitani H. Further development of influenza surveillance in China and global impact on influenza control. \textit{Int Congress Series} 2001;1219:119-22.
16. http://www.dh.gov.uk/PolicyAndGuidance/International/OverseasVisitors/OverseasVisitorsGeneralArticle/fs/en?CONTENT_ID=408070&chk=Olsixp.