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SHORT COMMUNICATION

Low prevalence of subclinical severe acute respiratory syndrome-associated coronavirus infection among hospital healthcare workers in Hong Kong

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Abstract

We recruited 688 hospital healthcare workers who cared for patients with severe acute respiratory syndrome (SARS) and did not develop the disease in the Hong Kong outbreak in 2003. A questionnaire survey was conducted and serum samples were collected for SARS-associated coronavirus (SARS-CoV) antibody. The high-risk procedures performed and the types of unprotected exposures were recorded for analysis. Only 1 asymptomatic nurse had positive serological test. The result demonstrates the low rate of subclinical SARS-CoV infection in hospital healthcare workers and that the infection control practice against SARS in Hong Kong's hospitals during the outbreak was highly effective.

Introduction

The Hong Kong Special Administrative Region was one of the worst hit areas by the severe acute respiratory syndrome (SARS) outbreak from February to June 2003. Among the 1755 suspected and confirmed cases of SARS in Hong Kong, healthcare workers constituted a significant proportion of patients. According to the Hong Kong Department of Health, 386 healthcare workers acquired SARS, accounting for 22% of the total local patient population [1]. Most of these healthcare workers worked in the public hospitals.

In the initial stage of the SARS outbreak, the World Health Organization (WHO) defined probable SARS according to clinical features, radiological findings and epidemiological link. With the discovery of the SARS-associated coronavirus (SARS-CoV) [2], laboratory tests were developed and incorporated into the WHO surveillance definition of probable SARS [3]. These tests included RNA

detection by reverse transcriptase-polymerase chain reaction (RT-PCR), SARS-CoV antibody detection by enzyme-linked immunosorbent assay (ELISA) or immunofluorescence assay (IFA), and virus isolation by culture.

Stringent and improved hospital infection control practice was introduced during the SARS outbreak. There has been no definite information in the literature on the intensity of high-risk procedures performed and the proportion with unprotected exposures among healthcare workers who did not develop SARS.

Four public regional hospitals in Hong Kong, namely Princess Margaret Hospital (PMH), Queen Mary Hospital (QMH), Pamela Youde Nethersole Eastern Hospital (PYNEH) and United Christian Hospital (UCH), cooperated to perform a study on the above issues under the auspices of the Hong Kong Hospital Authority. These hospitals had the experience of treating the majority of SARS patients in Hong Kong.

Materials and methods

The survey was conducted retrospectively in 4 public regional hospitals among healthcare workers of SARS wards, including 1 intensive care unit, who did not contract the disease. Participating subjects provided informed consent prior to being enrolled. They underwent serological test for SARS-CoV immunoglobulin-G (IgG) antibody and completed a self-administered questionnaire. Only 1 blood sample was taken from each participant since the exact time of exposure was unknown. The hospitals used the same questionnaire administered in 2 batches, with 1 hospital having acquired more detailed information from its healthcare workers prior to the inception of this study. The Statistics and Research Unit of the Hong Kong Hospital Authority merged the information obtained into a common database. The survey received approval from the Research and Ethics Committee of the Kowloon West Cluster of the Hong Kong Hospital Authority.

In the questionnaire, the following data were recorded: personal information, duty period in SARS wards, history of close contact outside hospital, protection during such contact, residence in a Department of Health listed SARS block, travel history, febrile illness during the period of SARS ward duty, high-risk procedures performed, and types of unprotected exposures. The participants consisted of 2 batches. The first batch (304 subjects) was from PMH and QMH and the questionnaire was completed in late May 2003. The second batch (384 subjects) was from all 4 hospitals and the questionnaire was completed in April 2004. In addition, the first batch from PMH (91 subjects) answered questions on a number of symptoms other than fever during SARS ward duty and the time of any sick leave taken.

Most blood samples were taken in late May to June 2003, except 20 subjects in QMH, who had blood samples collected in April 2004. We had chosen a commercially available whole-virus ELISA (GBI Biotech, Beijing, China) to test for the SARS-CoV IgG antibody. Samples that were ELISA positive were tested again by IFA.

The numerical data were recorded in numbers and proportions. Excel 2000 (Microsoft Inc., WA, USA) was used for data entry and calculations.

Results

There were 688 participants in the study and the distribution was: PMH 347 (50.4%), QMH 220 (32%), PYNEH 89 (12.9%) and UCH 32 (4.7%). Gender was available in 661 subjects with 541

females (81.8%) and 120 males (18.2%). Age was reported in 91 subjects, with a median of 36.3 y and a range of 23–59 y. The participants included 68 doctors (10.4%), 406 nurses (62.3%) and 178 healthcare assistants and other health auxiliaries (27.3%). The ranks were missing in the remaining 36 subjects.

These 688 subjects had worked in the SARS wards most of the time throughout the outbreak. Regarding the proportion of healthcare workers who had performed high-risk procedures (Table I), handling of infectious materials such as blood, body fluid and excreta headed the list, followed by nursing procedures such as oral feeding and bed bath. Ambu bagging and endotracheal intubation have been well known high-risk procedures but they were only reported by around 17% of participants. Unprotected exposures happened in a varying proportion of subjects (Table II). The most common events included taking care of undiagnosed patients later confirmed to be SARS cases, torn gloves, direct and indirect exposure to colleagues who later developed SARS and lapses in the use of personal protective equipment.

Fever was reported in 16.1% of 635 subjects who responded to the question on the history of febrile illness. In the PMH cohort, other more common complaints reported were headache (33.0%), sore throat (26.4%), malaise (23.1%), cough (23.1%), myalgia (22.0%), diarrhoea (18.7%), chills (11.0%), etc. Only 1 nurse out of all participants had a positive screening ELISA test for SARS-CoV IgG at the titre of 1:400, which was confirmed by the

Table I. Proportion of healthcare workers who had performed high-risk procedures.

High-risk procedures	Number	% performed
Ambu bagging	679	17.4
Intubation of patients	682	17.7
Physiotherapy	677	6.8
Oral feeding	680	59.6
Tracheostomy	587	4.8
Oral/nasopharyngeal suctioning	682	42.4
Endotracheal tube/tracheostomy suctioning	683	29.9
Performing cardiopulmonary resuscitation	480	15.6
Insertion of Ryle's tube	588	29.1
Performing bed bath	591	56.4
Handling patients' faeces	594	73.9
Handling patients' urine	593	75.7
Handling patients' vomit	593	52.9
Handling articles contaminated with blood or body fluid	393	76.1
Taking oral temperature	591	33.8
Last office for dead patients	589	27.2
Disposal of clinical waste	481	57.7

Table II. Proportion of healthcare workers who had unprotected exposures.

Types of unprotected exposures	Number	% exposed
Torn gloves	450	39.3
Forgetting to wear personal protective equipment (PPE)	449	7.4
Inappropriate PPE	448	26.1
Dropping PPE	447	16.6
Dining with colleagues later confirmed as SARS	447	24.6
Taking care of undiagnosed patients later confirmed as SARS	436	55.9
Sharing bathing and changing room facilities with colleagues later confirmed to be SARS	441	26.8
Staying in the same room with colleagues later confirmed as SARS	447	20.9
Needle prick injury	446	2.2

IFA. A further microneutralization test at the Hong Kong Government Virus Unit, a WHO reference laboratory, was also positive. She reported no symptoms in the survey performed in PMH in May 2003 [4] and in subsequent interviews.

Discussion

We conducted a survey on the performance of high-risk procedures, the occurrence of unprotected exposures and the rate of subclinical SARS infection in 688 healthcare workers in Hong Kong, who had worked in SARS wards in March to June 2003, without contracting the disease. For high-risk procedures, handling of infectious materials and nursing procedures were common and performed by many staff. It is natural that the proportion of subjects performing the above should be more than that for invasive procedures. Unprotected exposures of various forms were reported in the study. Nevertheless, the low rate of disease transmission even with such lapses may imply that direct exposure to a heavy viral load is required in the pathogenesis of SARS. The control group of healthcare workers who developed SARS was not included because in a retrospective review, these patients might have a much more significant recall bias than healthcare workers who were uninfected. Compensation considerations could also influence the response of these SARS victims.

The high attack rate among healthcare workers in the initial phase of the SARS epidemic was due to the lack of concept and training in protective measures against disease transmission [5]. The use of protective masks and the practice of droplets and contact precautions resulted in fewer staff infected and reduced risk of infection after exposure to SARS patients [6]. Studies elsewhere have already shown

infrequent subclinical SARS infection in healthcare workers [7–10]. In Hong Kong, studies have revealed the absence or rareness of subclinical infection in general practitioners who did not have SARS [11], in SARS ward healthcare workers without SARS (PMH preliminary study) [4], in all ranks of healthcare workers who were symptomatic or asymptomatic but without SARS [12] and in well healthcare workers exposed and not exposed to SARS [13]. Our study, which confirms the low prevalence of subclinical SARS infection in SARS ward healthcare workers without SARS, has the largest cohort of its kind reported to date. The positive rate was minuscule with only 1 asymptomatic nurse detected. In comparison with other studies, the lack of transmission in US hospitals [8] may have been associated with a relative absence of highly infectious patients or high-risk procedures. The report from Taiwan [11] did show infrequent transmission despite unprotected exposures to SARS in healthcare workers. However, the actual number of subjects who performed the respective high-risk procedures or were involved in different unprotected exposures had not been fully depicted.

One comment on our study is that the second batch of participants completed the questionnaire in April 2004, which is nearly 1 y after the end of the SARS outbreak. However, the high-risk procedures performed and incidences of unprotected exposures should remain a vivid memory among SARS ward healthcare workers. The tendency will be for some underestimation with the passage of time, but this will not be significant in the presence of low prevalence of subclinical infection. Reporting of fever and other complaints by SARS ward healthcare workers, attributable to the other respiratory viruses circulating at that time, should also be reasonably accurate. These workers were known to be very vigilant about their own health, and recall bias should be unlikely. Another comment on the study is that 20 subjects out of the total had blood sampling in April 2004 and the antibody titre could have fallen to undetectable levels; yet, SARS-CoV IgG has been shown to be detectable 1 y after the onset of illness by the usual methodology [14].

Why only a few people were infected by the SARS-CoV while most others were not is difficult to explain. One explanation is that the infection control measures were remarkably effective in those who comply. Another explanation is that the infective doses on exposure to the SARS-CoV, though markedly variable, were only high under certain environmental conditions. The third explanation is related to the individual's diverse genetic susceptibility to SARS infection, which affects the clinical outcome [15].

Another question is why most infections by the SARS-CoV are clinically manifest and subclinical infections are rare. One possible reason is that humans have never been exposed to the SARS-CoV and the immune system tends to react vigorously to this new agent [16].

In conclusion, we have demonstrated a low rate of subclinical infection by the SARS-CoV in the presence of high-risk procedures and instances of unprotected exposures. The result confirms the efficacy of the infection control measures instituted during the SARS outbreak in Hong Kong's hospitals. This finding is a reassuring message for healthcare workers who may be asked to care for patients suffering from SARS, which may re-emerge, or other new and highly contagious infections, in the future.

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