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Research letters

Effectiveness of precautions against droplets and contact in prevention of nosocomial transmission of severe acute respiratory syndrome (SARS)

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We did a case-control study in five Hong Kong hospitals, with 241 non-infected and 13 infected staff with documented exposures to 11 index patients with severe acute respiratory syndrome (SARS) during patient care. All participants were surveyed about use of mask, gloves, gowns, and hand-washing, as recommended under droplets and contact precautions when caring for index patients with SARS. 69 staff who reported use of all four measures were not infected, whereas all infected staff had omitted at least one measure (p=0·0224). Fewer staff who wore masks (p=0·0001), gowns (p=0·006), and washed their hands (p=0·047) became infected compared with those who didn't, but stepwise logistic regression was significant only for masks (p=0·011). Practice of droplets precaution and contact precaution is adequate in significantly reducing the risk of infection after exposures to patients with SARS. The protective role of the mask suggests that in hospitals, infection is transmitted by droplets.

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On March 12, 2003, WHO issued a worldwide alert for severe acute respiratory syndrome (SARS).[1] The hospital authority, which oversees all public hospitals in Hong Kong, had requested cases to be reported centrally since early February, in response to media reports of pneumonia outbreaks in Guangdong Province, People's Republic of China.[2] At that time, droplets precautions[3] and rigorous universal precautions[3] or standard precautions[3] were recommended for the care of patients with SARS. Here we report findings of a case-control study assessing the effectiveness of droplets precautions for prevention of nosocomial transmission.

We defined SARS as fever of 38°C or higher, radiological infiltrates compatible with pneumonia, and two of: chills, new cough, malaise, and signs of consolidation. We excluded patients who had known pathogens, radiological evidence of lobar consolidation, or who responded to antibiotics within 48 h.

Exposure to the virus was defined as coming within 0·91 m (3 feet) of an index patient with symptoms of SARS when providing care. Infected hospital staff were those who acquired SARS 2–7 days after exposure, with no exposure to cases outside the hospital.

For this study, index patients were selected only when there was documented clustering, indicating recent spread of infection. We could identify infected staff because since early February, notification of staff with SARS was mandatory in hospital-authority hospitals. We tested sera taken from index patients and infected hospital staff during the acute phase of the infection and during convalescence for antibodies to the corona-like virus[4] associated with SARS using an indirect immunoflourescence test.[4]

We excluded one hospital that had a large nosocomial outbreak because a drug nebuliser was used on an index patient with SARS for longer than 10 days. Droplets precautions have never been recognised as an effective infection control measure for such aerosol-generating procedures[5] and assessment of its efficacy seems inappropriate in the presence of such an apparent confounder.

A questionnaire was given to all infected and non-infected staff listed on the current roster in the clinical regions providing care for index patients with SARS. The names of index patients were listed on the questionnaire and the staff were asked if they had cared for these patients. Those who replied affirmatively were asked to indicate whether they had used mask, gloves, gowns, and hand-washing during patient care, selecting one of three responses: yes, most of the time, or no. These levels of response were to ensure that no indicated a definite lapse in practice. Staff who used masks were asked whether it was a paper mask, surgical mask, or N95 mask. The survey, which started on March 15, was done by the hospital's infection-control nurses and all responses were collected by March 24. Statistical analysis was done with SPSS version 10, with either χ^2 or Fisher's exact test for univariate analysis, whereas we used forward stepwise selection (Waldesian) for logistic regression.

We identified 11 index patients from five hospitals. None was nursed in negative-pressure rooms for the duration of illness. In three of the five hospitals, 13 hospital staff were

	Sex	Occupation	Unit	Protective measures during exposure
1	Female	Nurse	Emergency	*Paper mask/gloves/hand-washing
2	Female	Nurse	Medicine	Hand-washing
3	Female	Nurse	Medicine	Hand-washing
4	Female	Nurse	Medicine	Hand-washing
5	Female	Nurse	Medicine	Nil
6	Male	Nurse	Medicine	*Paper mask/hand-washing
7	Male	Doctor	Medicine	Gloves
8	Male	Doctor	Medicine	Hand-washing
9	Female	Health-care assistant	Medicine	Gloves/hand washing
10	Female	Health-care assistant	Medicine	Hand-washing
11	Female	Health-care assistant	Medicine	Hand-washing
12	Male	Health-care assistant	Medicine	Hand-washing
13	Female	Domestic staff	Medicine	Gloves

*2-layered paper mask.

Table 1: **Demographic profile of infected hospital staff**

	Infected Staff (n=13)	Non-infected staff (n=241)	p*	Odds ratio (95% CI)†
Protective measures‡				
Masks§	2 (15%)	169 (70%)	0·0001	13 (3–60)
Paper mask	2	26	0·511¶	
Surgical mask	0	51	0·007¶	
N95	0	92	0·0004¶	
Gloves	4 (31%)	117 (48%)	0·364	2 (0·6–7)
Gowns	0 (0%)	83 (34%)	0·006	NC
Hand-washing	10 (77%)	227 (94%)	0·047	5 (1–19)
All measures	0 (0%)	69 (29%)	0·022	NC

NC=not calculatable. *Two-tailed. †Odds ratio of staff with specific protection not getting infected. ‡"Yes" and "most of the time" were grouped together. §Total cases 254 by forward stepwise (Waldesian) logistic regression using 0·05 as entry probability and 0·10 as removal probability. Forward and backward stepwise regression result in same model with mask in the model (p=0·011). ¶Comparing proportion of infected over non-infected staff, with those without mask (11 infected and 72 non-infected).

Table 2: **Protective measures reported by infected and non-infected staff**

reported to have SARS after exposure to an index case. One infected staff member had no exposure to any admitted patient with SARS and was classified as a community-acquired infection. All index patients and infected staff in the study, except for one, showed a four-fold rise in the number of antibodies to corona-like virus.

356 completed questionnaires were returned, covering 85% of the staff on roster. Non-responders were mostly those on leave or night shift, which is rotated among the staff. We excluded 102 staff who had no contact with index patients. Most of the infected staff were from the medical wards (table 1), and omitted at least one of the four measures queried. Two who were using a mask reported only paper masks.

Staff who used masks, gowns, and handwashing were less likely to develop SARS than those who did not use them, but the association for gloves was not significant (table 2). None of the 69 staff reporting use of all four measures became infected. By contrast, all 13 infected staff had omitted at least one of the measures (p=0·0224). However logistic regression of the four measures with forward stepwise selection showed that only use of masks was significant in the final model (table 2).

The staff who wore surgical masks and N95 masks were significantly associated with non-infection (table 2), but this was not seen for paper masks.

That use of masks and hand-washing was associated with non-infection, and that no staff became infected when they used all four measures, suggest that precautions against droplets and contact are adequate for prevention of nosocomial SARS, where no aerosolisations are expected. The surgical and N95 masks were both effective in significantly reducing the risk of infection, which together with the finding that 30% of non-infected staff did not use masks (table 2) supports that transmission is not airborne. The finding that paper masks did not significantly reduce the risk is not unexpected. Such masks, being easily wet with saliva, are never recommended as a precaution against droplets.[3]

In any survey, recall bias is a concern. However, it probably had little effect since the associations shown are clear and the information requested was about simple concrete behaviour and events that took place recently. Masks seem to be essential for protection, since only this measure was significant in stepwise logistic regression. Thus, in hospital, the other three measures add no significant protection to the mask. This finding fits well with droplets transmission because droplets are generated at the face level making the mask crucial for protection.

Contributors

W H Seto is the main investigator and was involved in all aspects of the study. D Tsang, R W H Yung, T K Ng, and M Ho helped in the survey, and T Y Ching coordinated the infection-control nurses. L M Ho did the statistical analysis, and J S M Peiris organised the laboratory tests and supervised the writing of the report. The Expert Group advised on the clinical aspects of the report.

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Conflict of interest statement

None declared.

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Haemorrhagic-fever-like changes and normal chest radiograph in a doctor with SARS

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A 33-year-old doctor contracted severe acute respiratory syndrome presenting with features of disseminated intravascular coagulopathy without changes in the chest radiograph initially. A CT scan of his chest showed marked lung changes. His condition improved with intravenous methylprednisolone 500 mg daily and ribavirin 1·2 g orally thrice daily. The case illustrates the importance of a break in fever between the viraemic and lung inflammatory phases of the illness that