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SHORT COMMUNICATION

The changing face of healthcare worker perceptions on powered air-purifying respirators during the SARS outbreak

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Objectives: Before the advent of severe acute respiratory syndrome (SARS), use of the powered air-purifying respirator (PAPR) in the setting of pulmonary tuberculosis has been controversial. Data regarding health care worker (HCW) perceptions and problems encountered with the use of the PAPRs were lacking.
Methodology: A questionnaire-based survey was conducted of HCWs who had used the PAPR in clinical practice during the SARS outbreak, when use of the PAPR was mandatory and widespread. Evaluations of the question of whether HCWs were receptive to the use of the PAPR and their perceptions of common problems that were encountered were made. Perceptions of comfort, ease of use, visual, hearing, breathing and speech impairment, perceived protection against SARS and usage preferences were recorded.
Results: Only a minority of respondents found the PAPR uncomfortable, despite some interference with communication. Despite its much higher cost, the majority (84%) preferred to use the PAPR rather than the N-95 respirator when treating suspected SARS patients. However, opinions were equally divided regarding its use when treating patients with pulmonary tuberculosis; with 51% being in favour.
Conclusions: With the advent of highly contagious diseases that pose a major occupational hazard to HCWs, the use of the PAPR has become more acceptable in clinical practice.

Key words: health care worker, perceptions, powered air-purifying respirator, severe acute respiratory syndrome, survey.

INTRODUCTION

Strict infection control measures were instituted in Singapore with the emergence of severe acute respiratory syndrome (SARS) in March 2003. All heath care workers (HCWs) caring for patients suspected of having SARS were required to wear gloves, gowns, goggles and N-95 respirators, while powered air-purifying respirators (PAPR) were mandatory for high-risk or aerosol-generating procedures.[1] 'N' class signifies protection against non-oil-based aerosols and '95' means that the respirator is at least 95% efficient at filtering particles with a median diameter greater than 0.3 μm.[2]

In contrast to the disposable N-95 respirator, the PAPR has a motor that draws air through a filter, delivering filtered air under positive pressure to a hood.[3] It is also more costly, with the 3M PAPR (3M, USA) costing about US$860 as compared to the disposable N-95 that costs only $0.70 at the National University Hospital, Singapore. Another model, the T4 Personal Protection System (Stryker, USA), costs about US$580.

PAPR use in the health care setting has been controversial. When the National Institute for Occupational Safety and Health (NIOSH) proposed, in September 1992,[4] that HCWs exposed to tuberculosis patients wear PAPR instead of disposable respirators, there were objections by both hospital officials and doctors. The main concerns were that PAPR would add greatly to the cost of care, that doctors would

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Figure 1 A doctor wearing a PAPR with glasses, goggles and N-95 respirator.

appear frightening to their patients (Fig. 1), and that the motor's hissing sound would interfere with patient communication.[5]

Widespread use of PAPRs in the National University Hospital, Singapore, during the SARS outbreak enabled us to conduct a questionnaire-based survey of health care workers who had actually used the PAPR in clinical practice.

METHODS

The purpose of this survey was to study the use of PAPR in clinical practice with respect to the following points: (i) comfort; (ii) ease of use; (iii) impairment of vision, breathing, speech and hearing; (iv) perceived level of protection against SARS; (v) perceived appearance to the patient; and (vi) usage preference. The questions had five possible answers, with the exception of the question on perceived level of protection against SARS, for which respondents were required to give their estimated percentage. There were separate identical sections for the 3M PAPR and the Stryker PAPR for points (i) to (iii) but no subdivision of the subsequent questions.

This cross-sectional survey was conducted in mid-May 2003, more than a month after the same hospital advocated the use of PAPR. It was administered to HCWs who had used the PAPR at least once in three primary areas (intensive care unit, endoscopy centre, and emergency department) and who agreed to complete the questionnaire. The questionnaires were then collected and checked for completeness.

RESULTS

A total of 51 HCWs completed the questionnaire, including 19 doctors, 31 nurses/nursing aides, and a respiratory therapist who each generated a single response. For the initial part of the questionnaire, covering the aforementioned first three points, respondents filled either the section for the 3M or the Stryker PAPR, or both sections if they had used both PAPRs. The female : male ratio was 2 : 1. There were 43 responses for the 3M PAPR and 22 responses for the Stryker PAPR, as 14 HCWs had used both and generated responses for both sections. In total, 27 HCWs had used the PAPR in the intensive care unit, with the remaining respondents having used it in the emergency department or endoscopy centre (12 each).

In total, 25 of the 43 respondents for the 3M PAPR were taught how to use it by someone who had been trained, 14 received video instruction, and five relied on printed instructions, with five being educated in more than one of the aforementioned ways. Three HCWs taught themselves to use the PAPR by self-experimentation alone. Among respondents for the Stryker PAPR where no video was available, only one referred to printed instructions while the rest were taught by someone who was trained.

The PAPR were used by the 51 HCWs on a total of 392 occasions, for the following indications: intubation and non-airway procedures ($n = 133$); nonairway procedures, examination and nursing of patient ($n = 142$); endoscopy (bronchoscopy and gastrointestinal; $n = 70$); and transport of intubated ($n = 35$) and non-intubated patients ($n = 12$).

Tables 1 and 2 summarize the results for each model of PAPR. The majority of respondents who used the PAPR found it to be at least tolerable with respect to comfort. For the 3M PAPR, 74% found it to be easy or relatively easy to use, 23% found it moderately difficult to use, while only 3% found it relatively difficult to use. For the Stryker PAPR, 91% found it to be easy or relatively easy to use and 9% found it relatively difficult to use.

Although about two-thirds of respondents wore glasses and a third wore goggles in addition to the PAPR, the majority (98% and 95% for the 3M and Stryker PAPR, respectively) found the level of visual impairment attributable to the PAPR to be at least acceptable.

Adhering to hospital recommendations on PAPR use, all respondents wore N-95 respirators underneath the PAPR. One-third rated the breathing discomfort attributable to the N-95 respirator to be 'comfortable with minimal perceived work of breathing', another one-third rated it as 'comfortable with moderate perceived work of breathing', and just under one-quarter rated it as 'uncomfortable'. The results for level of breathing discomfort attributable to the 3M and Stryker PAPR are shown in Tables 1 and 2, respectively.

Table 1 Perceived comfort and impairment of vision, breathing, speech and hearing with the 3M powered air-purifying respirator

Percentage of total responses for the 3M PAPR ($n = 43$)					
Comfort	Very comfortable	Slight discomfort	Tolerable	Moderate discomfort	Uncomfortable
	23.3%	30.2%	32.6%	11.6%	2.3%
Visual impairment	Nil	Negligible	Noticeable	Acceptable	Unacceptable
	25.6%	18.6%	27.9%	25.6%	2.3%
Breathing discomfort	Nil	Comfortable, minimal WOB	Comfortable, moderate WOB	Uncomfortable	Suffocating
	25.6%	60.5%	7.0%	4.6%	2.3%
Speech impairment	Can speak normally	Raise voice mildly	Raise voice moderately	Raise voice significantly	Shout
	4.6%	32.6%	37.2%	25.6%	0%
Hearing impairment	Nil	Mild	Moderate	Significant	Unacceptable
	16.3%	41.9%	27.9%	11.6%	2.3%

PAPR, powered air-purifying respirator; WOB, work of breathing.

Table 2 Perceived comfort and impairment of vision, breathing, speech and hearing with the Stryker powered air-purifying respirator

Percentage of total responses for the Stryker PAPR ($n = 22$)					
Comfort	Very comfortable	Slight discomfort	Tolerable	Moderate discomfort	Uncomfortable
	45.5%	31.8%	13.7%	4.5%	4.5%
Visual impairment	Nil	Negligible	Noticeable	Acceptable	Unacceptable
	22.7%	54.6%	4.5%	13.7%	4.5%
Breathing discomfort	Nil	Comfortable, minimal WOB	Comfortable, moderate WOB	Uncomfortable	Suffocating
	45.5%	31.8%	22.7%	0%	0%
Speech impairment	Can speak normally	Raise voice mildly	Raise voice moderately	Raise voice significantly	Shout
	13.7%	27.3%	31.8%	27.3%	0%
Hearing impairment	Nil	Mild	Moderate	Significant	Unacceptable
	27.3%	45.5%	22.7%	4.5%	0%

PAPR, powered air-purifying respirator; WOB, work of breathing.

A total of 14% of respondents found the hearing impairment when using the 3M PAPR to be significant or unacceptable, while it was significant for only 5% when using the Stryker PAPR. Keeping in mind the concomitant use of the N-95 respirator, only 5% of respondents could speak normally when using the 3M PAPR and about one-quarter had to raise their voice significantly (Table 1). When using the Stryker PAPR, 14% could speak normally while 27% had to raise their voice significantly (Table 2).

About two-thirds of respondents agreed (22%) or strongly agreed (42%) that they looked frightening to their patients whenever they used the PAPR. The mean perceived level of protection against SARS was 91.1 ± 9.7% for the PAPR and 81.7 ± 17.5% for the N-95 respirator.

A total of 84% of respondents agreed or strongly agreed with the statement 'for potential SARS cases, routine use of the PAPR (with gown and gloves) is preferable to using the N-95 respirator (with goggles, cap, gown and gloves), despite the significantly higher cost of the PAPR'. Only 51% felt that routine use of the PAPR was preferable for infectious cases, such as pulmonary tuberculosis patients, despite costs.

DISCUSSION

All types of respirators are unpleasant to wear and may compromise vision and communication, as well as increase the work of breathing.[2] As comfort and communication are important factors for compliance with the use of masks,[2] this survey addressed these issues for use of the PAPR. The PAPR is more comfortable, because of the cooling effect of air blowing over the face, and has less impact on the work of breathing.[3] However, it is bulky, heavy, requires maintenance, and interferes with communication.

When the NIOSH first recommended the use by HCWs of the PAPR with high-efficiency particulate filters for tuberculosis more than a decade ago, this recommendation was met by criticism from members of

the US medical community,[4] who argued that it was too extreme and that such respirators would interfere significantly with patient care.

This study describes the perceptions of HCWs who had actually used the PAPR themselves during the SARS outbreak. Our findings are consistent with the initial concerns of US doctors in 1992,[5] that the PAPR makes the wearer look frightening and interferes with communication. In contrast, we found that PAPR use is more acceptable in the context of SARS. This could be because most HCWs perceive the SARS coronavirus to be highly contagious and more deadly than tuberculosis. Also, with the lack of an effective cure for SARS, prevention and infection control are given a high priority.

The role of the PAPR will become increasingly important in an era when highly contagious pathogens pose a major occupational hazard for HCWs. With its acceptability, a potential concern is that HCWs may have a sense of complacency whenever they use the PAPR.

Further studies evaluating the efficacy and use of various models of the PAPR in clinical practice are required, as this was not the purpose of this survey. In addition, the importance of education regarding the limitations of PAPRs, and instruction on its proper use, cleaning and maintenance should also be reinforced so that this acceptability translates to efficacy and safety.

REFERENCES

1 Centers for Disease Control and Prevention. Severe acute respiratory syndrome—Singapore, 2003. *Morb. Mortal. Wkly. Report* 2003; **52**: 405–11.

2 Martyny J, Glazer CS, Newman LS. Respiratory protection. *N. Engl. J. Med.* 2002; **347**: 824–30.

3 Fennelly KP. Personal respiratory protection against Mycobacterium tuberculosis. *Clin. Chest Med.* 1997; **18**: 1–17.

4 Leidel NA, Mullan RJ. *NIOSH-Recommended Guidelines for Personal Respiratory Protection of Workers in Health-Care Facilities Potentially Exposed to Tuberculosis*. US Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, Atlanta, GA, 1992.

5 Nelson H. USA Objections to protective respirators. *Lancet* 1992; **340**: 1088.