Appropriate use of personal protective equipment among healthcare workers in public sector hospitals and primary healthcare polyclinics during the SARS outbreak in Singapore

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Background: Singapore was affected by an outbreak of severe acute respiratory syndrome (SARS) from 25 February to 31 May 2003, with 238 probable cases and 33 deaths.

Aims: To study usage of personal protective equipment (PPE) among three groups of healthcare workers (HCWs: doctors, nurses, and administrative staff), to determine if the appropriate PPE were used by the different groups and to examine the factors that may determine inappropriate use.

Methods: A self-administered questionnaire survey of 14 554 HCWs in nine healthcare settings, which included tertiary care hospitals, community hospitals, and polyclinics, was carried out in May–July 2003. Only doctors, nurses, and clerical staff were selected for subsequent analysis.

Results: A total of 10 236 valid questionnaires were returned (70.3% response); 873 doctors, 4404 nurses, and 921 clerical staff were studied. A total of 32.5% of doctors, 48.7% of nurses, and 77.1% of the administrative staff agreed that paper and/or surgical masks were "useful in protecting from contracting SARS". Among this group, 23.6% of doctors and 42.3% of nurses reported working with SARS patients. The view that a paper and/or surgical mask was adequate protection against SARS was held by 33.3% of doctors, 49.4% of nurses from medical wards, and 27.5% of doctors and 37.1% of nurses from intensive care units. Factors which predicted for agreement that paper and/or surgical masks were protective against SARS, included HCW's job title, wards, and Impact Events Scale scores.

Conclusion: A variety of factors determine appropriate use of personal protective equipment by HCWs in the face of a major SARS outbreak.

Severe acute respiratory syndrome (SARS), a viral respiratory illness caused by the coronavirus, SARS-CoV, is possibly the first globally significant occupational disease to emerge in the 21st century. Coronavirus are single stranded RNA viruses causing disease in human and animals. Other known corona viruses have also been known to cause the common cold in humans. Most studies of SARS cases in which transmission occurred from a single point of exposure have reported an incubation period between 2 and 10 days. 1 SARS is an occupational disease which the world is beginning to come to grips with, and a grim reminder that healthcare work is potentially hazardous. 2 Those in direct contact with patients, especially involving aerosol generating procedures, were at highest risk. 3 In some cases, transmission to healthcare workers (HCWs) occurred even when they were wearing masks, eye protection, gowns, and gloves.

The primary mode of transmission appears to be through direct or indirect contact of mucous membrane (eyes, nose, or mouth) with infectious respiratory droplets or fomites. 1 Outbreaks involving large numbers of SARS patients have been linked to the use of aerosol generating procedures; for example, endotracheal intubation, bronchoscopy, and treatment using aerosolised medication. 1 The role of the faecal-oral route is unknown but may be important. Person-to-person spread by infected droplets is the most important mode of spread. When the infected person coughs, droplets containing the virus are released into the surroundings and infect those around this sick person. This explains the spread of SARS to HCWs, and family members and friends which have been reported in many studies. 4, 5

The outbreak of SARS in Singapore was first reported on 12 March 2003 (http://www.gov.sg/moh/sars/news/chronology.html). The index patient was hospitalised at Tan Tock Seng Hospital (TTSH), which subsequently became the country's designated SARS hospital. This index patient infected 20 others (both patients and HCWs), who in turn became the secondary sources of spread of the infection. The last case of probable SARS occurred on 5 May 2003. There were a total of 238 SARS cases in Singapore from March to May 2003, with 33 deaths. 6

In other occupational exposure, engineering measures (for example, enclosure, local exhaust ventilation, substitution, etc) could be adopted more easily. But for HCWs the most important means of protecting them against SARS is to equip them with personal protective equipment (PPE). Therefore the choice of PPE and their correct usage are of paramount importance.

The Ministry of Health (MOH), Singapore Manual for SARS Infection Control in Hospitals dated 26 April 2003 stated that "Personal protective equipment (PPE) including..."
Main messages

- A variety of factors determine appropriate use of personal protective equipment by HCWs in the face of a major SARS outbreak.
- A sizable number of HCWs were not familiar with the protection levels of the different type of respiratory protection.

Policy implications

- It is important not only to emphasise the right respiratory protection to be used but also to ensure that what is being communicated is carried out by all levels of HCWs.

hand hygiene, gown, gloves, and N95 respirators in addition to eye protection are mandatory for health-care workers to prevent transmission of SARS in health-care settings”. The Manual went on to further emphasise “the basic recommended protective attire for CONTACT WITH SARS SUSPECT OR SARS PROBABLE PATIENTS includes fit tested N95 respirators, goggles or face shields, disposable long sleeved gowns and disposable gloves”. Based on the available literature, it is generally believed (if the PPE are correctly worn) that powered air purifying respirators (PAPR) offered the highest level of protection against infected aerosol of SARS patients followed by N95. Surgical masks may offer a certain level of protection, while paper masks generally offer little or no protection to the HCWs. Goggles protect the HCW against splashes of fluid from the SARS patients. Other protection included gloves, gowns, hair covers, and shoe covers.

How closely are the MOH instructions being followed by the HCWs and what is their understanding of the protective nature of the PPE? It was with the above in mind that the study was conducted with the objectives: (1) to determine the use of PPE among three groups of HCWs (doctors, nurses, and clerical staff); (2) to determine if the correct PPE was being worn by each group; and (3) to examine the factors associated with incorrect PPE use.

METHODS

This paper reports the results for a subset of a larger study involving 15 025 HCWs employed in nine healthcare settings in the public sector, who were invited to participate in a self-administered anonymous questionnaire survey from May to July 2003. The healthcare settings included the three SARS affected tertiary hospitals, a non-affected hospital for women and children, two community hospitals, two dental centres (one of which was located within a SARS affected hospital), and nine primary care clinics belonging to one of two healthcare clusters in Singapore. The two dental centres are excluded in the present report. Furthermore, only doctors, nurses, and clerical staff (those least likely to be exposed to SARS) are included.

The questions were on occupational and sociodemographic data, perception of risk of infection and preventive measures, and the impact of the SARS outbreak on personal and work life. The responses were recorded on a six point Likert scale (1 = strongly disagree, 6 = strongly agree) with scores of 1–3 taken as indicative of negative response, and 4–6 as a positive response. Respondents also completed an abbreviated Impact of Event Scale (IES), which is a measure of stress reactions after a traumatic event.” In our questionnaire, one question on the IES avoidance subscale (“My feelings about it were kind of numb”) was inadvertently omitted, which resulted in an abbreviated IES score. Ethical approval was obtained from the Institutional Review Boards of the respective institutions.

The six page questionnaire was given to a designated coordinator from the Human Resource Department of the respective institution. The coordinator would then disseminate it to the respective departments in the institution. A deadline was given for the return of the questionnaire. Participation was strictly voluntary and the responses anonymous. No additional attempts were made to get the individuals to respond when the deadline was passed. The study questionnaires were processed by an optical reader with pre-written editing programs.

Statistical analysis

We used SPSS version 11.5 (SPSS Inc, Chicago, USA) for the analysis of data. The questions beginning with a stem such as “I believe that the following measures are useful in protecting me from contracting SARS...” Individuals who agreed that paper and/or surgical masks were effective were grouped together as “agreed” for all subsequent analysis. In addition to univariate descriptive statistics, we performed multiple logistic regression to determine the significant factors that were associated with the view that usage of paper/surgical masks was protective against SARS.

Logistic regression analysis was used to evaluate significant factors predicting a response which agrees that paper and/or surgical masks were protective against SARS, adjusting for significant possible risk factors. Odds ratios and 95% confidence intervals (CI) were calculated, using the lowest risk group as the referent. The following variables were entered into the multiple logistic regression models: age, length of service, job title, nature of work, area of work, and IES scores.

RESULTS

The overall response rate was 70.3%. The response rates were much better in the community hospitals and the polyclinics compared with general hospitals (table 1). We were interested in how knowledgeable the doctors, nurses, and clerical staff in the various healthcare settings were with regard to the effectiveness of the different PPE. Table 2 shows the knowledge of effectiveness of PPE by doctors, nurses, and clerical staff. The types of PPE were grouped under respiratory and others, and within each group the PPE are ranked in descending order starting with the most effective. A total of 10.2% of the doctors agreed that paper masks were protective, while 30.1% agreed that surgical masks were protective. The percentages for nurses were higher (34.9% and 52.1%, respectively), and for clerical staff, the highest (55.7% and 85.3%, respectively). In contrast, the responses from the other PPE (N95 mask, goggles, PAPR, gowns, hair cover, gloves) were fairly homogeneous among the three groups (table 2).

Individuals who agreed that paper and/or surgical masks were effective were grouped together as “agreed” for all
In the prevention of occupational disease, controlling the
hazard at source is always the foremost guiding principle.
HCWs come in contact with varied groups of people from all
walks of life. It would be very difficult to apply this principle.
Of course, healthcare institutions did set up other safeguards;
for example, temperature screening for all individuals coming
into the hospital, special protocols for managing febrile
patients, isolation wards, respiratory isolation, and barrier
precautions. But ultimately, the last line of defence is the
appropriate use of personal protective devices, especially that
of an effective respiratory protection.

The questions asked to the participants on usage of PPE
began with a stem “I believe that the following measures are
useful in protecting me from contracting SARS…” The range
of PPE available to HCWs which we studied is listed in table 2.
Generally, more than 85% of the participants agreed that
goggles, gowns, hair cover, and gloves were useful in pro-
tecting them from contracting SARS. With regard to res-
piratory protection (paper mask, surgical mask, and N95
mask), the responses were more varied; 10.2% and 34.9% of
the doctors and nurses, respectively, agreed that a paper
mask, and 30.1% and 52.1% of the doctors and nurses,
respectively, agreed that a surgical mask was protective
against contracting SARS (table 2). Although we know much
more about the nature of the virus and the mode of
transmission, such was not the case during the outbreak
and indeed not even during the time of the study. There was
also some controversy as to what level of protection was
“adequate”. This controversy may have contributed in some
to this finding.

Another possible reason for this finding could be the
variable interpretation of this question by the respondents.
Some respondents could have interpreted the statement “I
believe that the following measures are useful in protecting
me from contracting SARS” to mean that having these
measures was better than not having any protection Therefore,
it would be “useful in protecting me from contracting SARS”.
However, if it was just an interpretational observation, we
would expect more respondents to agree and the distribution
for agreeing to the different type of masks to be fairly similar
across the three groups, which is not so (table 2). Of course,
the belief that a paper/surgical mask may be adequate does
not mean that such individuals would only use this level of
protection. Also relevant may be the range of other measures
in place, especially temperature screening and other control
measures employed. These measures may give the confidence
that things were under control.

Seto and colleagues conducted a case-control study with
241 non-infected and 13 infected staff in five Hong Kong
hospitals. They reported that “staff who wore surgical masks
and N95 masks were significantly associated with non-
infection, but this was not seen for paper masks”. Although
this is a small study which may not be representative of the
general population, it certainly points to the ineffectiveness
of paper masks against SARS. Loeb and colleagues con-
ducted a retrospective study among 43 critical care units with
SARS patients in Toronto. They reported a “…near 80%
reduction in risk of infection for nurses who consistently
wore masks (either surgical or N95). … compared with use of
N95 to use of surgical masks, the relative SARS risk associ-
ated with the N95 mask was half that for the surgical
mask.” These papers suggest that surgical masks do provide
some protection, but an N95 mask would give a higher
protection. In fact, the US Centers for Disease Control and
Prevention (CDC) report recommended “a respirator that is
at least as protective as an N-95 respirator approved by the
National Institute for Occupational Safety and Health (NIOSH)” for protection against SARS.

It was for this reason that we combined individuals who
agreed that a paper mask and/or surgical mask was protective
against SARS into one category versus those who disagree
that paper and surgical masks were protective. A total of
32.5% of doctors and 48.7% of nurses agreed that paper
masks and/or surgical masks were protective against SARS.

Table 2 Knowledge of effectiveness of personal protective equipment (PPE) by doctors, nurses, and clerical staff

<table>
<thead>
<tr>
<th>Types of PPE</th>
<th>Doctors (n = 873)</th>
<th>Nurses (n = 4404)</th>
<th>Clerical staff (n = 921)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Agree* (%)</td>
<td>Disagree† (%)</td>
<td>Agree* (%)</td>
</tr>
<tr>
<td>PAPR</td>
<td>765 (87.2)</td>
<td>37 (4.3)</td>
<td>3910 (87.0)</td>
</tr>
<tr>
<td>N95 mask</td>
<td>849 (97.5)</td>
<td>5 (0.6)</td>
<td>4330 (99.4)</td>
</tr>
<tr>
<td>Surgical mask</td>
<td>825 (95.6)</td>
<td>18 (2.1)</td>
<td>2102 (95.9)</td>
</tr>
<tr>
<td>Paper mask</td>
<td>84 (10.2)</td>
<td>739 (89.8)</td>
<td>1388 (34.9)</td>
</tr>
<tr>
<td>Goggles</td>
<td>787 (94.0)</td>
<td>50 (6.0)</td>
<td>4149 (97.6)</td>
</tr>
<tr>
<td>Gloves</td>
<td>825 (98.9)</td>
<td>9 (1.1)</td>
<td>4280 (99.4)</td>
</tr>
<tr>
<td>Gowns</td>
<td>798 (95.6)</td>
<td>37 (4.4)</td>
<td>4268 (98.9)</td>
</tr>
<tr>
<td>Hair cover</td>
<td>692 (84.3)</td>
<td>129 (15.7)</td>
<td>3909 (95.0)</td>
</tr>
</tbody>
</table>

*A Agree that the PPE is effective against contracting SARS.
†Disagree that the PPE is effective against contracting SARS.
PAPR, powered air purifying respirator.
Among the staff who agreed, 23.6% of the doctors and 42.3% of the nurses reported that their work “involves daily contact with SARS patients”. Even in high risk areas such as the A&E and medical units, at least a quarter of the doctors and nurses agreed that paper and/or surgical masks were adequate protection.

The A&E unit, being the first stop for possible SARS patients, would be the unit most at risk. Patients with fever would generally be admitted to a medical unit. It would have been better if staff managing these units used a more effective respirator. On a more positive note, individuals who had higher probability of coming in contact with SARS were more likely to wear effective respirators compared to the administrative staff (table 4). This observation showed that knowledge of a possible exposure risk, assuming that administrative work carries the least likely exposure to SARS, is more likely to help an individual make a better choice.

The IES is a self-report scale that assesses two categories of cognitive responses to stressful events: intrusion (intrusively experienced ideas, images, feelings, or bad dreams), and avoidance (consciously recognised avoidance of certain ideas, feelings, or situations). The scale was originally developed to assess current distress associated with a specific trauma. However, studies have reported that IES is also a valid measure of post-traumatic stress disorders. It is interesting to note that individuals with mean IES scores of >20 are more likely to disagree that paper and/or surgical masks are protective against SARS. In this case it would imply that individuals who felt more stressed, with a heightened level of anxiety, were more likely to be vigilant and opt for a higher level of protection.

HCWs caring for patients with SARS or other types of infectious diseases which can be transmitted from direct patient contact or contact with large respiratory droplets in the close vicinity of an infected person patient should be properly trained in the correct use and removal of PPE, and reminded of the importance of hand hygiene. There have been reports of clusters of SARS cases among protected HCWs. Some of the reasons cited for these cases were: “no formal respiratory protection programme existed”, “individual workers had not been fit tested”, “mask did not fit well”, and “lacked a clear understanding of how best to remove PPE without contaminating themselves”. There may be a gap between knowledge and practice. HCWs may not be aware that the N95 mask should be used rather than paper and/or surgical masks. This study was carried out in May–July 2003. The N95 mask was the recommended mask for HCWs who may come in contact with SARS. In fact, the Ministry of Health, Singapore Manual for SARS Infection Control in Hospitals, dated 26 April 2003

#### Table 3  Basic characteristics of doctors, nurses, and clerical staff who agreed that paper and/or surgical masks are protective against SARS

<table>
<thead>
<tr>
<th></th>
<th>Doctors</th>
<th></th>
<th>Nurses</th>
<th></th>
<th>Clerical Staff</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Agreed (%)</td>
<td>Total</td>
<td>Agreed (%)</td>
<td>Total</td>
<td>Agreed (%)</td>
</tr>
<tr>
<td><strong>Types of institution</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>General hospitals (4)</td>
<td>763</td>
<td>249</td>
<td>36.6</td>
<td>4043</td>
<td>1977</td>
<td>38.3</td>
</tr>
<tr>
<td>Polyclinics (9)</td>
<td>99</td>
<td>33</td>
<td>33.3</td>
<td>191</td>
<td>84</td>
<td>44.0</td>
</tr>
<tr>
<td>Community hospitals (2)</td>
<td>11</td>
<td>2</td>
<td>18.2</td>
<td>170</td>
<td>84</td>
<td>49.4</td>
</tr>
<tr>
<td><strong>Nature of work</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SARS patients</td>
<td>233</td>
<td>55</td>
<td>23.6</td>
<td>1228</td>
<td>520</td>
<td>42.3</td>
</tr>
<tr>
<td>Non-SARS patients</td>
<td>770</td>
<td>218</td>
<td>28.3</td>
<td>3516</td>
<td>1697</td>
<td>48.3</td>
</tr>
<tr>
<td>Members of the public</td>
<td>365</td>
<td>97</td>
<td>26.6</td>
<td>1780</td>
<td>852</td>
<td>47.9</td>
</tr>
<tr>
<td>NA</td>
<td>22</td>
<td>9</td>
<td>40.9</td>
<td>73</td>
<td>53</td>
<td>72.6</td>
</tr>
<tr>
<td><strong>Area of work</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Surgical discipline</td>
<td>271</td>
<td>70</td>
<td>25.8</td>
<td>803</td>
<td>387</td>
<td>48.2</td>
</tr>
<tr>
<td>Medical discipline</td>
<td>341</td>
<td>104</td>
<td>30.5</td>
<td>1219</td>
<td>602</td>
<td>49.4</td>
</tr>
<tr>
<td>ICU</td>
<td>40</td>
<td>11</td>
<td>27.5</td>
<td>496</td>
<td>184</td>
<td>37.1</td>
</tr>
<tr>
<td>A&amp;E</td>
<td>42</td>
<td>14</td>
<td>33.3</td>
<td>93</td>
<td>52</td>
<td>55.9</td>
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<tr>
<td>Radiographic services</td>
<td>38</td>
<td>9</td>
<td>23.7</td>
<td>16</td>
<td>9</td>
<td>56.3</td>
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<tr>
<td>Laboratory services</td>
<td>22</td>
<td>11</td>
<td>50.0</td>
<td>4</td>
<td>3</td>
<td>75.0</td>
</tr>
<tr>
<td>Administrative</td>
<td>3</td>
<td>–</td>
<td>–</td>
<td>35</td>
<td>17</td>
<td>46.6</td>
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<tr>
<td>Others</td>
<td>86</td>
<td>26</td>
<td>30.2</td>
<td>1412</td>
<td>730</td>
<td>51.7</td>
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<td><strong>Nationality</strong></td>
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<tr>
<td>Local</td>
<td>744</td>
<td>208</td>
<td>28.0</td>
<td>3011</td>
<td>1408</td>
<td>46.8</td>
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<tr>
<td>Foreign staff</td>
<td>124</td>
<td>41</td>
<td>33.1</td>
<td>1376</td>
<td>731</td>
<td>53.1</td>
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<tr>
<td><strong>Mean age (y)</strong></td>
<td>–</td>
<td>35.8</td>
<td>–</td>
<td>–</td>
<td>34.6</td>
<td>–</td>
</tr>
<tr>
<td><strong>Mean length of experience (y)</strong></td>
<td>–</td>
<td>11.4</td>
<td>–</td>
<td>–</td>
<td>12.8</td>
<td>–</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>509</td>
<td>154</td>
<td>30.3</td>
<td>146</td>
<td>67</td>
<td>45.9</td>
</tr>
<tr>
<td>Female</td>
<td>358</td>
<td>97</td>
<td>27.1</td>
<td>4244</td>
<td>2071</td>
<td>48.8</td>
</tr>
<tr>
<td><strong>Ethnic group</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese</td>
<td>709</td>
<td>202</td>
<td>28.5</td>
<td>2339</td>
<td>1004</td>
<td>42.9</td>
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<tr>
<td>Malay</td>
<td>7</td>
<td>1</td>
<td>14.3</td>
<td>618</td>
<td>329</td>
<td>53.2</td>
</tr>
<tr>
<td>Indian</td>
<td>89</td>
<td>24</td>
<td>27.0</td>
<td>548</td>
<td>255</td>
<td>46.3</td>
</tr>
<tr>
<td>Filipino</td>
<td>20</td>
<td>7</td>
<td>35.0</td>
<td>755</td>
<td>478</td>
<td>63.3</td>
</tr>
<tr>
<td>Others</td>
<td>42</td>
<td>17</td>
<td>40.5</td>
<td>92</td>
<td>49</td>
<td>53.3</td>
</tr>
<tr>
<td><strong>Mean IES score</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intrusive</td>
<td>–</td>
<td>7.8</td>
<td>–</td>
<td>–</td>
<td>9.5</td>
<td>–</td>
</tr>
<tr>
<td>Avoidance</td>
<td>–</td>
<td>7.3</td>
<td>–</td>
<td>–</td>
<td>11.2</td>
<td>–</td>
</tr>
</tbody>
</table>

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stated: “...the Ministry of Health recommends the use of N95 or equivalent respirators/masks” and “the N95 respirator or equivalent mask must be used according to manufacturer’s instructions and fitted so that there is a proper seal between the masks sealing surface and the wearer’s face”. In spite of all the reminders, there is still a sizable number of HCWs who may be ignorant of this. Perhaps there should be a more concerted effort to pass information down the line. Different groups of individuals may not be getting the necessary information or may not understand the message.

During the SARS outbreak, some of the health institutions did not have enough N95 masks to supply all staff. The supply did not meet the unexpected huge demand, especially during the first few weeks. It was very difficult to get supplies of N95 masks. Hence, some hospitals had to prioritise and balances in place to ensure that what is expected is being carried out correctly. Otherwise, HCWs run the risk of being infected.11

Table 4  Significant factors predicting a response which agrees that paper and/or surgical masks are protective against SARS

<table>
<thead>
<tr>
<th>Area of work</th>
<th>OR*</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administrative</td>
<td>1.00</td>
<td>0.869 to 1.145</td>
</tr>
<tr>
<td>Surgical</td>
<td>0.59</td>
<td>0.385 to 0.885</td>
</tr>
<tr>
<td>Medical</td>
<td>0.63</td>
<td>0.431 to 0.934</td>
</tr>
<tr>
<td>Intensive care</td>
<td>0.37</td>
<td>0.249 to 0.574</td>
</tr>
<tr>
<td>A&amp;E</td>
<td>0.83</td>
<td>0.514 to 1.364</td>
</tr>
<tr>
<td>Radiographic services</td>
<td>0.62</td>
<td>0.316 to 1.224</td>
</tr>
<tr>
<td>Laboratory services</td>
<td>1.54</td>
<td>0.727 to 3.267</td>
</tr>
<tr>
<td>Others</td>
<td>0.72</td>
<td>0.498 to 1.059</td>
</tr>
</tbody>
</table>

**Impact Events Scale (IES) scores**

IES < 19 1.061 0.867 to 1.307

IES > 20 0.866 0.769 to 0.974

*Odds ratios derived using a multiple logistic regression model adjusting for age, length of service, job title, nature of work, area of work, and IES scores, where applicable.

**REFERENCES**


**Conclusion**

A variety of factors determine appropriate use of personal protective equipment by HCWs in the face of a major SARS outbreak. This study also highlights the importance of not only emphasising the right respirators to be used, but also the need to ensure that what is being communicated is carried out by all levels of HCWs.

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