Author’s response to reviews

Title: Contamination by respiratory viruses on outer surface of medical masks used by hospital healthcare workers

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Rudra Channappanavar

BMC Infectious Diseases

RE: Contamination by respiratory viruses on outer surface of medical masks used by hospital healthcare workers

Authors: Abrar A Chughtai, PhD; Sacha Stelzer-Braid; William Rawlinson; Giulietta Pontivivo; Quanyi Wang; Yang Pan; Daitao Zhang; Yi Zhang; Lili Li; Chandini Macintyre
Dear Dr. Rudra

Thank you for the opportunity to revise our paper. We have revised it according to reviewers’ comments, and attach the revised version and a response to the reviewers’ comments.

Please do not hesitate to contact us should you require any further clarification

Abrar Ahmad Chughtai
Lecturer
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Sen Pei, Ph.D. (Reviewer 1):

1. In line 118, "Most particles were concentrated on upper right, middle and left sections of the masks". I am wondering how many experiments were performed to reach this conclusion. Does the direction or distance of spray affect the concentration area?

Authors’ reply: We performed three experiments from the front and three from the side of mannequin to confirm the findings. We have added following statement; “We performed three experiments from the front and three experiments from the sides of mannequin”. Please see lines 118-119.

We also modified following statement, “In all three experiments, most particles were concentrated on upper right, middle and left sections of the masks”. Please see lines 120-121.

Most infection control guidelines recommend use of masks within 1 meter (3 feet) of the infective patient. This is based on assumption that droplets particles (>5 μm) do not suspend for long in the air and usually travel a distance of less than 1 meter. Therefore, fluorescent particles were sprayed from a distance of approximately 1 meter in all experiments.

2. In pilot study 2 (clinical testing), 3 samples were positive for human enterovirus. Could authors report in which sections those viruses were found? Is it consistent with the finding in pilot study 1?

Authors’ reply: Based on the findings of first pilot study, the samples were taken from only upper three sections of masks in the second pilot study. Therefore, all positive samples were from upper sections. We mentioned that, “Medical masks were divided into six sections as
shown in figure 3. Samples were taken from upper three sections of masks i.e. 36 samples were tested in total (12 masks X 3 samples). Please see lines 130 to 132.

3. As the masks were only tested on the upper section, it would be better to stress in the abstract that the results were based on the data from the upper section. Other sections might be contaminated as well.

Authors’ reply: We have modified following statements in the abstracts, “Used samples of medical masks were tested for presence of respiratory viruses on upper sections of the medical masks, in line with the pilot studies.”. Please see lines 53 and 54.

We also added following statement, “Viruses were isolated from the upper sections of around 10% samples, but other sections of masks may also be contaminated”. Please see lines 69 and 70.

4. The internal medicine department has a much higher contamination rate. Is there any intuitive explanation? Does this imply different protocols should be applied in distinct departments?

Authors’ reply: We agree with the reviewer that higher contamination rates in internal medicine department might be due to using different protocols in these departments. This may also be due to high risk perception and adopting more precautions in respiratory and pediatric departments. However, the sample sizes and number of positive results were too low to make meaningful comparisons between departments. We have added following statement, “Virus positivity rates were also higher in those working in internal medicine department compared to respiratory and pediatric departments. The reason of high virus positivity in internal medicine department is not clear, but this may be due to using varying infection control policies and practices. High risk perception and more infection control measures may result in low virus positivity in in respiratory and pediatric departments. However, the sample sizes and number of positive results were too low to make meaningful comparisons between departments”. Please see line 267-273.

5. Is there any particular reason to choose the 6-hour boundary? I am wondering if statistically significant difference could be obtained using other threshold values.

Authors’ reply: “Duration of mask use” was recorded in hours as, < 1 hour, 1 to 2 hours, 2 to 4 hours, 5 to 6 hours, 7 to 8 hours, >8 hours. We used 6-hour boundary as HCWs were asked to use masks for minimum 6-8 hours, i.e. during a typical work shift. We mentioned, “HCWs from the participating wards were asked to wear medical masks for a shift (6-8 hours) or as long as they could tolerate the masks with no adverse event”. Please see the method section (lines 147 to 148).
Another reason of using two categories was small sample size in this study. We mentioned in the paper that around two third of participants used masks for > 6 hours during the study period - 80 participants (54.1%) used masks for “7-8 hours” and 19 participants (12.8%) used masks for “>8 hours”. The remaining one third participants used masks for ≤6 hours – “1-2 hours” 1 participant (0.7%), “3-4 hours” 8 participants (5.4%) and “5-6 hours” 40 participants (27%). Please see lines 208 to 211. Rates of virus positivity in various groups are presented in the table below. (Also see attached file, authors reply)

<table>
<thead>
<tr>
<th>Duration of mask use</th>
<th>Virus positivity</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 2 hours</td>
<td></td>
<td>0/1</td>
<td>0</td>
</tr>
<tr>
<td>3 to 4 hours</td>
<td></td>
<td>1/8</td>
<td>12.5</td>
</tr>
<tr>
<td>5 to 6 hours</td>
<td></td>
<td>0/40</td>
<td>0</td>
</tr>
<tr>
<td>7 to 8 hours</td>
<td></td>
<td>11/80</td>
<td>13.8</td>
</tr>
<tr>
<td>&gt; 8 hours</td>
<td></td>
<td>3/19</td>
<td>15.8</td>
</tr>
</tbody>
</table>

We have also showed relationship between duration of mask use and virus positivity in the figure (Please see attached file, authors reply).

6. If the number of examined patients is available, it would be better to see a more refined correlation between positive cases and number of patients in more groups (instead of examining just two groups). Pertaining to the last question, how was the threshold of 25 patients per day selected?

Authors’ reply: Given small sample size we used two groups - threshold of 25 patients per day was selected to make equal distribution in two groups (77 and 71 cases in each group). There was a linear relationship in the dataset, between number of patients seen and virus positivity. Please see below analysis using four nearly equal categories. We are happy to change this in the main table. (Also see attached file, authors reply)
Patients’ seen   Virus positivity   OR (95% CI)

<table>
<thead>
<tr>
<th>Number</th>
<th>Percent</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1-8</td>
<td>1/39</td>
<td>2.6</td>
<td>Ref</td>
</tr>
<tr>
<td>8-20</td>
<td>2/33</td>
<td>6.1</td>
<td>2.45  (0.21-28.32)</td>
</tr>
<tr>
<td>21-40</td>
<td>3/32</td>
<td>9.4</td>
<td>3.93  (0.40 -39.77)</td>
</tr>
<tr>
<td>&gt;40</td>
<td>9/44</td>
<td>20.5</td>
<td>9.77  (1.77-81.11)</td>
</tr>
</tbody>
</table>

We have also showed relationship between number of patients seen and virus positivity in the figure (Please see attached file, authors reply).

7. A table of the collected information from participants would help readers to better understand the experiments. Some detailed information, for instance, variable name and type (categorical/numerical), should be reported.

Authors’ reply: We have added details of collected information from the patients in the methods section. We added following paragraph: “At the end of the study, HCWs were asked to complete a short survey to collect information on mask use in routine (type of mask used, number of masks used and situations when masks were normally used) and during the study period (wearing time, number of patients seen, situations when masks were used, aerosol generating procedures performed and hand hygiene during donning and doffing). Participants reported “number of masks used” and “number of patients seen” in absolute numbers. “Duration of mask use” was recorded in hours as, < 1 hour, 1 to 2 hours, 2 to 4 hours, 5 to 6 hours, 7 to 8 hours, >8 hours. “Situations when masks were used” were categorized into: “used continuously”, “used continuously except during breaks”, “used only during patients’ encounters” and “used only high-risk patient encounters”. Please see line 153 to 161.

8. Is there any clustering of a certain type of virus in a certain department? Or different types of virus appear in all three?

Authors’ reply: Commonly isolated viruses from masks samples were adenovirus (n=7), bocavirus (n=2), respiratory syncytial virus (n=2) and influenza virus (n=2). Most of these viruses (13/15) were isolated from internal medicine department (Table 3). Adenoviruses, bocaviruses, respiratory syncytial viruses were isolated from internal medicine department.
Influenzas viruses were isolated from both respiratory and paediatric department. As suggested by review, we have added this information in table 2. Please see lines 466 to 467.

We agree with the reviewer that this clustering may be due to change or using different protocols in these departments or just by chance. However, the sample sizes and number of positive results were too low to make meaningful comparisons between departments. Larger scale studies are needed to explore this question.

9. In lines 252 and 254, there seems to be a repetition of sentence.

Authors’ reply: Thanks for pointing out this. We have deleted the following sentence, “Theoretically, the risk of infection in wearer may be higher if contaminated masks are used for prolonged time”. Please see lines 256 and 257.

Rudra Channappanavar, DVM, Ph.D. (Reviewer 2):

1. Major Comments: As author's mention in the last paragraph of discussion, this study has several caveats. One major weakness of this study is that this study fails to prove if the viruses on masks were the result of endogenous or exogenous source. It is very important to provide this information, especially as adenovirus is associated with mild or no respiratory illnesses and that adenovirus is a major virus identified in this study. Any screening information about the participant is helpful in justifying these results.

Authors’ reply: We agree with the reviewer that an adenovirus may be associated with mild or no respiratory illnesses, and we acknowledged this in limitation section. We have modified following paragraph: “Although none of the participant had a respiratory or a medical illness, it is not possible to determine whether viruses isolated from the masks surface were from exogenous or endogenous source. For example, adenovirus was most commonly identified in this study and is associated with mild or no respiratory illnesses. Ideally participants should also be swabbed to rule out infections, and the inside surface should also be tested. To overcome this limitation, detailed history on respiratory symptoms was taken to rule out contamination of masks by clinically ill participants themselves.” Lines 296-302.