

Short Communication

Measurement of Cough-Wind Pressure: Masks for Mitigating an Influenza Pandemic

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SUMMARY: To assess the degree to which face masks reduce the strength of cough-wind, we measured the wind pressure in front of the mouth with and without the wearing of masks. We found that any conventional mask made from paper, cotton gauze, or non-woven fabrics reduced the wind pressure to less than one-tenth of that recorded when no mask was worn.

We previously reported that conventional masks greatly reduce the velocity of cough-wind, and proposed that providing masks to people with flu-related coughing is a cost-effective countermeasure for an influenza pandemic (1). In the present study, we measured the pressure (instead of the velocity) of cough-wind, and found that masks also greatly reduce this; thus further confirming the ability of masks to block the thrust of cough-wind.

A polypropylene funnel (6 cm internal diameter) was held by hand in front of the mouth of subjects who deliberately coughed. A vinyl tube was connected from the funnel to a differential pressure transducer (DP45-14; Validyne, Northridge, Calif., USA), from which an electric signal was transmitted to an amplifier (PA501; Krone, Tokyo, Japan) (Fig. 1). Voltage from the amplifier, proportional to the stagnation pressure of the wind expressed as Pa (Pascal), was recorded at 2-ms intervals on a personal computer. The cough sound was also recorded with a sound level meter (NL-20; Rion, Tokyo, Japan).

The masks used were the same as those in our previous report (1): masks made of 2-ply paper (CN103; AzOne, Tokyo, Japan), 3-ply polypropylene non-woven fabric (CN102W; AzOne), and 16-ply cotton gauze (Kowa, Nagoya, Japan). Five healthy adults (1 male, 4 females) coughed deliberately 30 times each with and without masks.

Figure 2 shows the stagnation pressure at the funnel bottom, recorded from a subject wearing a paper mask during the first half of the recording session, and the pressure recorded in the absence of the mask during the second half.

The pressure levels recorded without masks from 5 subjects were 99 ± 20 , 102 ± 21 , 148 ± 31 , 194 ± 44 , and 206 ± 42 Pa; the mean level for the 5 subjects was 150 Pa. The pressure levels with paper masks were 7.5

± 2.9 , 9.5 ± 2.3 , 13.9 ± 2.0 , 15.7 ± 4.3 , and 7.0 ± 2.4 Pa, respectively; the mean was 10.7 Pa (Fig. 3). Cough-wind pressure was calculated as having been reduced 14-fold by the paper mask.

The pressure levels with non-woven fabric and cotton-gauze masks were slightly lower than those with



Fig. 1. A device for recording the cough-wind pressure. A subject wearing a mask holds a funnel in front of the mask.

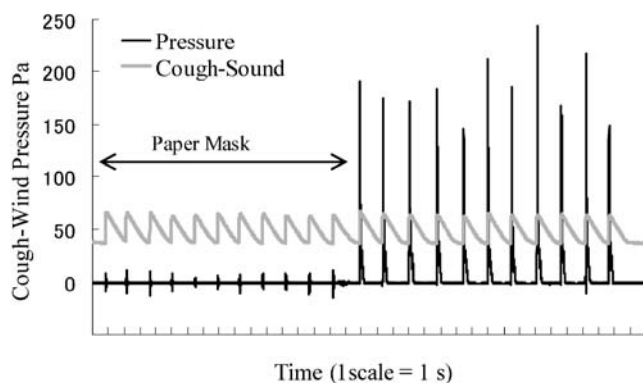


Fig. 2. Cough-wind pressure with and without a paper mask. A paper mask was worn during the first half of the recording session. Black line, cough-wind pressure. Gray line, cough-sound level (relative scale).

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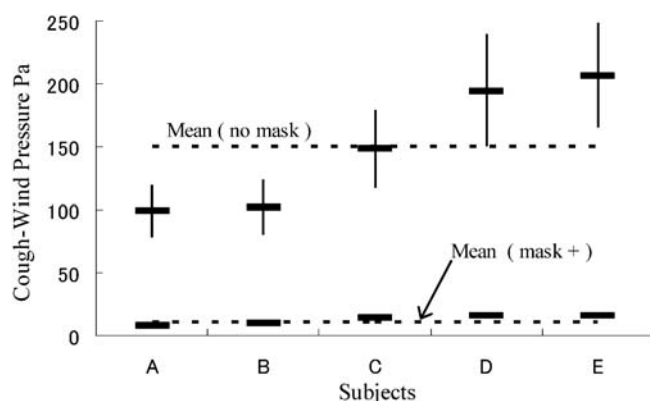


Fig. 3. Reduction of cough-wind pressure by a paper mask. Cough-wind pressure was measured 30 times each with and without masks for five subjects. Vertical lines indicate the range within ± 1 SD of the pressure levels of each subject. Two dotted lines indicate the mean of the average pressure among the five subjects with and without masks, respectively.

paper masks (data not shown).

There are controversies as to whether influenza is mainly transmitted via droplets or droplets + droplet nuclei (2,3). However, regardless of such controversies, if the virus is spread by coughing, then when the mouth is blocked, the transmission of infection in the community is inhibited. Reducing the cough-wind pressure/velocity by means of wearing face masks would result in the reduction in the spread of the virus from those suffering from influenza.

There have been reports which indicate some efficacy of face masks against influenza-like illness transmission in households (4,5) and university residence halls (6). If a new subtype influenza was to emerge, it would be possible to mitigate a pandemic if all people with flu-related coughing wore a mask of some kind, particularly during the period when newly produced vaccines are yet to be made available.

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