Respiratory virus shedding in exhaled breath and efficacy of face masks

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Abstract

We identified seasonal human coronaviruses, influenza viruses and rhinoviruses in the exhaled breath and coughs of children and adults with acute respiratory illness. Surgical face masks significantly reduced detection of influenza virus RNA in respiratory droplets and coronavirus RNA in aerosols, with a marginally significant reduction in coronavirus RNA in respiratory droplets. Our results indicate that surgical facemasks could prevent transmission of human coronaviruses and influenza viruses from symptomatic individuals.

Methods

Data collection

Participants were recruited year-round from March 2013 through May 2016 in a general outpatient clinic of a private hospital in Hong Kong. Individuals who reported ≥2 symptoms of acute respiratory illness (ARI, including fever≥37.8ºC, cough, sore throat, runny nose, headache, myalgia and phlegm), within 3 days of illness onset and ≥11 years of age were eligible to participate in the study. All participants provided a nasal swab and a separate throat swab for subsequent virologic confirmation at the laboratory. All participants also completed a questionnaire to record basic information including age, sex, current ARI symptoms, medical conditions and smoking history. Eligible participants were then invited to provide an exhaled breath sample for 30 minutes in the same clinic visit.

Prior to the exhaled breath collection, each participant was randomly allocated in a 1:1 ratio to either wearing a surgical face mask (Cat #62356, Kimberly-Clark, Roswell, Georgia) or not during the collection. Participants were asked to attach the surgical mask themselves, but instruction on how to wear the mask properly was given when the participant wore the mask incorrectly. Participants were instructed to breathe as normal during the collection, but (natural) coughing was allowed and the number of coughs was recorded by study staff. Participants were then invited to provide a second exhaled breath sample of the alternate type, but most participants did not agree to stay for a second measurement. Exhaled breath particles were captured and differentiated into two size fractions, the coarse fraction containing particles with aerodynamic diameter >5μm (referred to here as 'respiratory droplets') which included droplets up to approximately 100 μm in diameter, and the fine fraction with particles ≤5μm (referred to here as 'aerosols') by the "G-II" bioaerosol collecting

device.

Nasal swab samples were first tested by a diagnostic-use viral panel, xTAG Respiratory Viral Panel (Abbott Molecular, Illinois, USA), to detect qualitatively twelve common respiratory viruses and subtypes including coronaviruses (NL63, OC43, 229E and HKU1), influenza A (non-specific, H1 and H3) and B viruses, respiratory syncytial virus (RSV), parainfluenza virus (types 1-4), adenovirus, human metapneumovirus, and enterovirus/rhinovirus. After one or more of the candidate respiratory viruses was detected by the Viral Panel from the nasal swab, all the samples from the same participant, i.e. the nasal swab, throat swab, the respiratory droplets and aerosols, were then tested with reverse transcriptase real-time polymerase chain reaction (RT-PCR) specific to the candidate virus(s) for determination of viral load in the samples. Infectious influenza virus was identified by viral culture using MDCK cells.

Ultimately 246 individuals were enrolled and provided exhaled breath samples. Among these 246 participants, 122 (50%) participants were randomized to not wearing a face mask during the first exhaled breath collection and 124 (50%) participants randomized to wearing a face mask. 49 (20%) voluntarily provided a second exhaled breath collection of the alternate type. Three groups of respiratory viruses with highest frequency of infection were identified by RT-PCR, namely coronavirus (including NL63, OC43, HKU1 and 229E), influenza virus, and rhinovirus. Therefore, the present dataset included the viral load for coronavirus, influenza virus and rhinovirus, as well as anonymized data of participiants' basic information and symptoms, for these 246 individuals.

Data processing

The data provided here was minimally processed.

Usage Notes

Attached 10 files to generate all figures (except Extended Data Figure 1) and tables in:
Leung, N. H. L. *et al.* Respiratory virus shedding in exhaled breath and efficacy of face masks. *Nat. Med.*, doi:10.1038/s41591-020-0843-2 (2020).

The 10 files include:
1) Dataset: G2resp_data_200324.csv
2) Data dictionary: G2resp_dictionary_200324.csv
3) R scripts: 1 x master script + 7 x sub-scripts

Please run the master script which will then source all the sub-scripts:

Master
G2resp_00_master_script_200324.R

Transform viral load data
G2resp_01_Viral_shedding_transformation_200324.R

Extended Data Figure 2
G2resp_02_Weekly_number_of_respiratory_virus_infections_200324.R

Extended Data Figure 3
G2resp_03_Respiratory_virus_shedding_200324.R

Table 1a, Supplementary Table 1
G2resp_04_Patient_characteristics_200324.R

Figure 1, Extended Data Figure 4, Extended Data Figure 5, Extended Data Figure 9
Table 1b, Supplementary Table 2, Supplementary Table 3
G2resp_05_Efficacy_of_surgical_face_masks_200324.R

Extended Data Figure 6, Extended Data Figure 7, Extended Data Figure 8
G2resp_06_Correlation_of_respiratory_viral_shedding_between_samples_200324.R

Supplementary Table 4, Supplementary Table 5, Supplementary Table 6
G2resp_07_Factors_associated_with_respiratory_viral_shedding_200324.R

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References

This dataset is supplement to https://doi.org/10.1038/s41591-020-0843-2

This dataset cites https://doi.org/10.21203/rs.3.rs-16836/v1

Keywords

Infectious Diseases, influenza virus, coronavirus, aerosol, face mask, Public health, Respiratory infections

Files

10 files for this dataset

G2resp_00_master_script_200324.R	3.77 kB	application/octet-stream
G2resp_01_Viral_s...rmation_200324.R	8.42 kB	application/octet-stream
G2resp_02_Weekly_...ections_200324.R	10.19 kB	application/octet-stream
G2resp_03_Respira...hedding_200324.R	12.10 kB	application/octet-stream
G2resp_04_Patient...ristics_200324.R	21.97 kB	application/octet-stream
G2resp_05_Efficac...e_masks_200324.R	47.54 kB	application/octet-stream
G2resp_06_Correla...samples_200324.R	10.72 kB	application/octet-stream
G2resp_07_Factors...hedding_200324.R	19.08 kB	application/octet-stream
G2resp_data_200324.csv	166.96 kB	text/csv
G2resp_dictionary_200324.csv	25.40 kB	text/csv

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