COVID-19 Community of Practice for Ontario Family Physicians

Peter Jüni MD FESC

peter.juni@utoronto.ca

Scientific Director, Ontario COVID-19 Science Advisory Table

Director, Applied Health Research Centre (AHRC)
Li Ka Shing Knowledge Institute, St. Michael's Hospital

Professor of Epidemiology & Medicine, University of Toronto

Tier 1 Canada Research Chair in
Clinical Epidemiology of Chronic Diseases

UNIVERSITY OF TORONTO

SCIENCE TABLE
COVID-19 ADVISORY FOR ONTARIO

Routes of transmission

REVIEW

CURRENT OPINION

Controversy around airborne versus droplet transmission of respiratory viruses: implication for infection prevention

Eunice Y.C. Shiu, Nancy H.L. Leung, and Benjamin J. Cowling

Purpose of review

Health agencies recommend transmission-based precautions, including contact, droplet and airborne precautions, to mitigate transmission of respiratory viruses in healthcare settings. There is particular controversy over the importance of aerosol transmission and whether airborne precautions should be recommended for some respiratory viruses. Here, we review the current recommendations of transmission-based precautions and the latest evidence on the aerosol transmission of respiratory viruses.

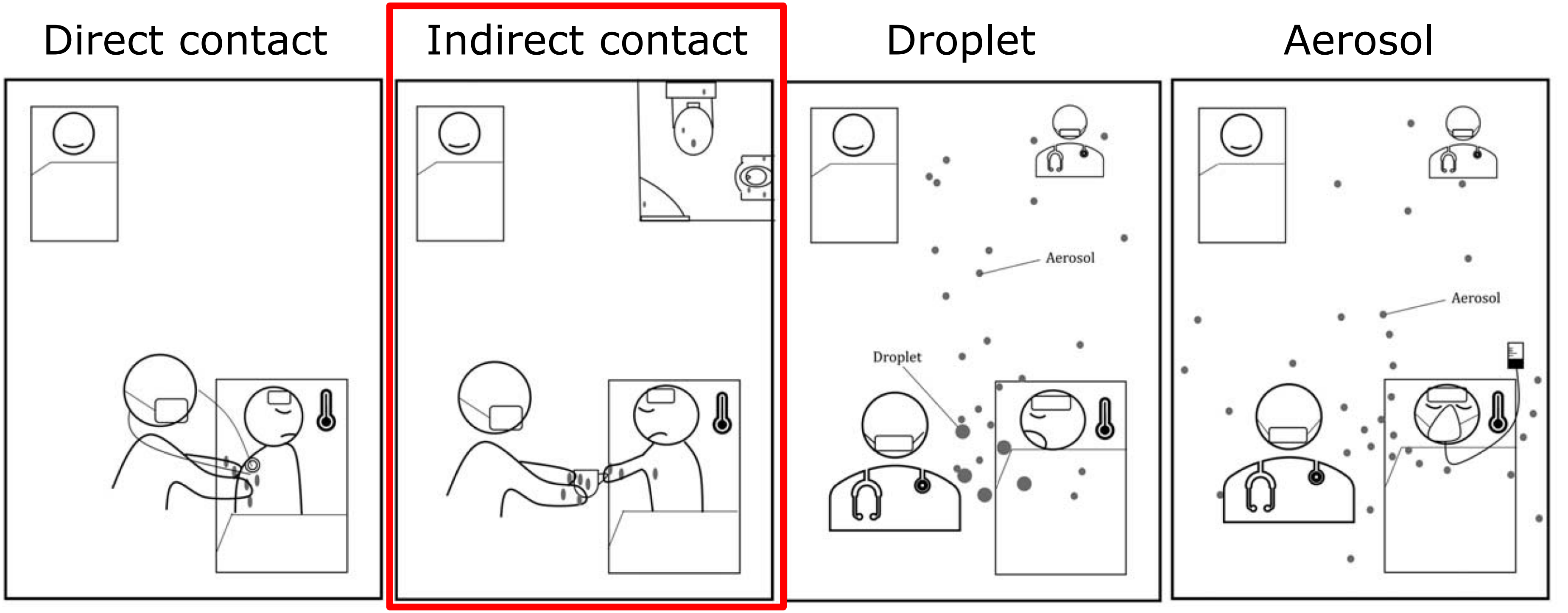
Recent findings

Viral nucleic acids, and in some instances viable viruses, have been detected in aerosols in the air in healthcare settings for some respiratory viruses such as seasonal and avian influenza viruses, Middle East respiratory syndrome-coronavirus and respiratory syncytial virus. However, current evidences are yet to demonstrate that these viruses can effectively spread via airborne route between individuals, or whether preventive measures in airborne precautions would be effective.

Summary

Studies that use transmission events as outcome to demonstrate human-to-human transmission over the aerosol route or quantitative measurement of infectious respiratory viruses in the air are needed to evaluate the infectiousness of respiratory viruses over the aerosol route. When a respiratory virus in concern only leads to disease with low severity, airborne precautions are not likely to be justified.

Shiu et al, Curr Opin Infect Dis. 2019



Shiu et al, Curr Opin Infect Dis. 2019

Indirect contact

CORRESPONDENCE

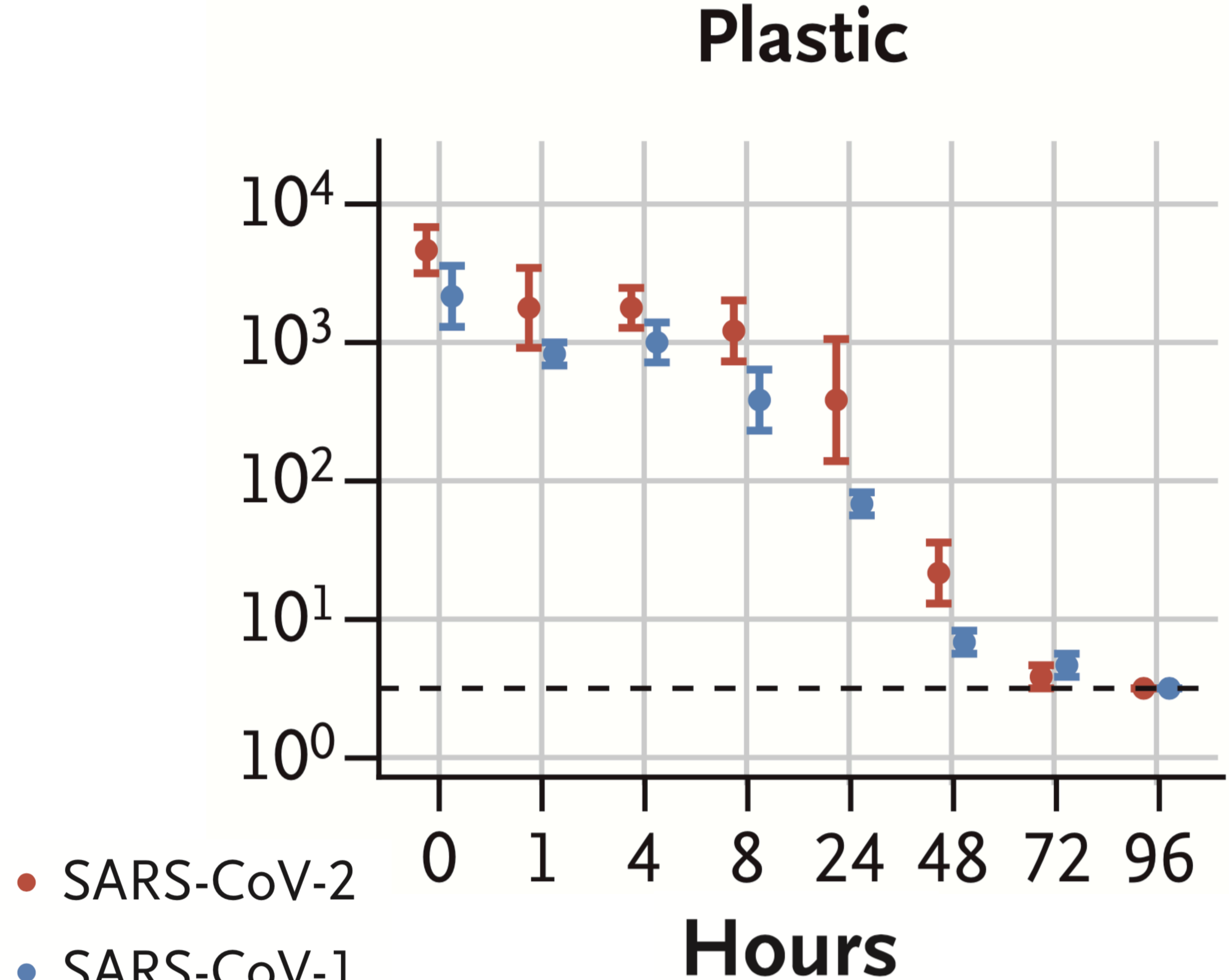
Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1

TO THE EDITOR: A novel human coronavirus that is now named severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (formerly called HCoV-19) emerged in Wuhan, China, in late 2019 and is now causing a pandemic.[1] We analyzed the aerosol and surface stability of SARS-CoV-2 and compared it with SARS-CoV-1, the most closely related human coronavirus.[2]

We evaluated the stability of SARS-CoV-2 and SARS-CoV-1 in aerosols and on various surfaces and estimated their decay rates using a Bayesian regression model (see the Methods section in the Supplementary Appendix, available with the full text of this letter at NEJM.org). SARS-CoV-2 nCoV-WA1-2020 (MN985325.1) and SARS-CoV-1 Tor2 (AY274119.3) were the strains used. Aerosols (<5 μm) containing SARS-CoV-2 ($10^{5.25}$ 50% tissue-culture infectious dose [$TCID_{50}$] per milliliter) or SARS-CoV-1 ($10^{6.75-7.00}$ $TCID_{50}$ per milliliter) were generated with the use of a three-jet Collison nebulizer and fed into a Goldberg drum to create an aerosolized environment. The inocu- $10^{0.6}$ $TCID_{50}$ per milliliter of medium after 72 hours on plastic and from $10^{3.7}$ to $10^{0.6}$ $TCID_{50}$ per milliliter after 48 hours on stainless steel). The stability kinetics of SARS-CoV-1 were similar (from $10^{3.4}$ to $10^{0.7}$ $TCID_{50}$ per milliliter after 72 hours on plastic and from $10^{3.6}$ to $10^{0.6}$ $TCID_{50}$ per milliliter after 48 hours on stainless steel). On copper, no viable SARS-CoV-2 was measured after 4 hours and no viable SARS-CoV-1 was measured after 8 hours. On cardboard, no viable SARS-CoV-2 was measured after 24 hours and no viable SARS-CoV-1 was measured after 8 hours (Fig. 1A).

Both viruses had an exponential decay in virus titer across all experimental conditions, as indicated by a linear decrease in the $\log_{10}TCID_{50}$ per liter of air or milliliter of medium over time (Fig. 1B). The half-lives of SARS-CoV-2 and SARS-CoV-1 were similar in aerosols, with median estimates of approximately 1.1 to 1.2 hours and 95% credible intervals of 0.64 to 2.64 for SARS-CoV-2 and 0.78 to 2.43 for SARS-CoV-1 (Fig. 1C, and Table S1 in the Supplementary Ap-

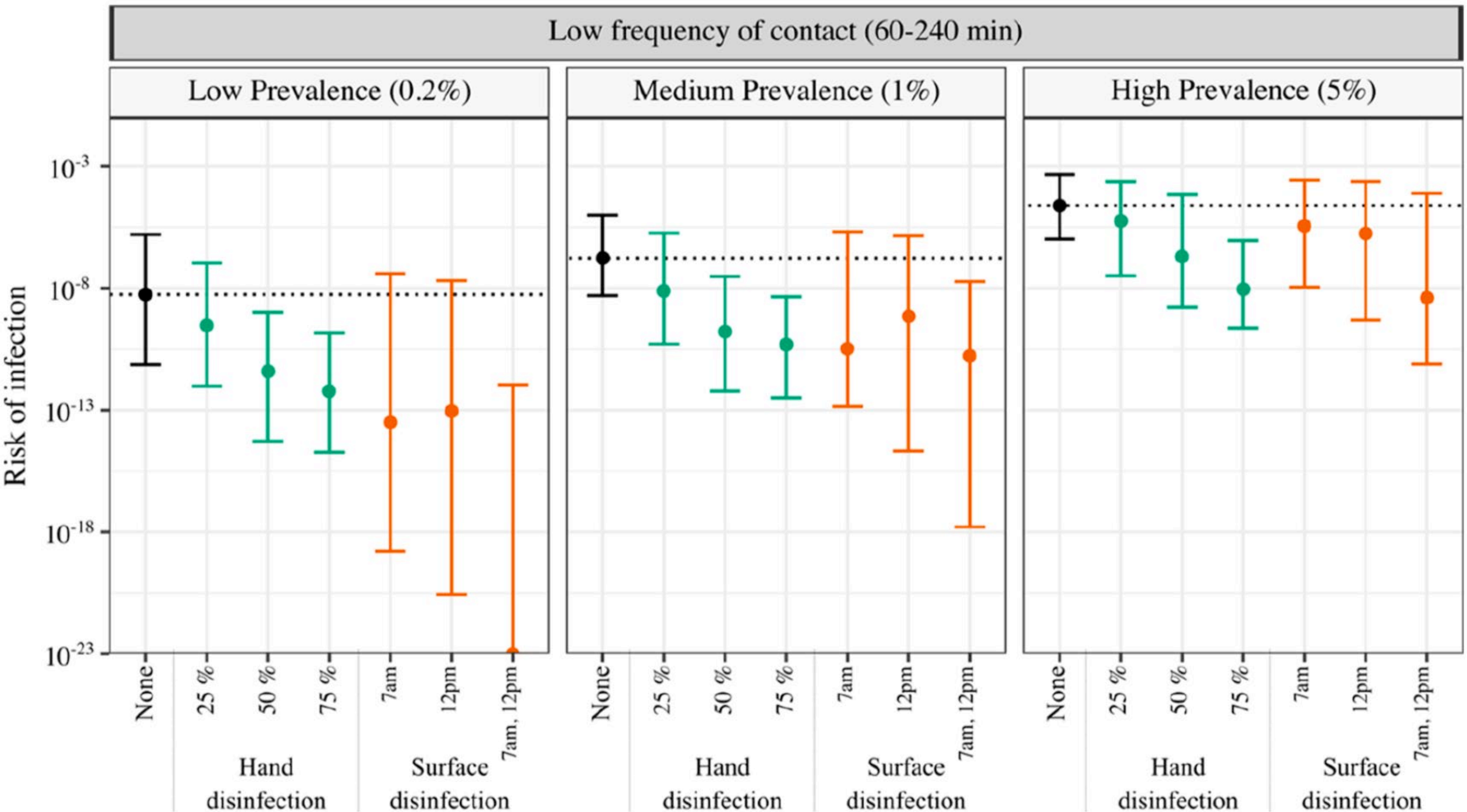
van Doremalen et al, N Engl J Med 2020



van Doremalen et al, N Engl J Med 2020

Type of virus	Duration of persistence (range)
Adenovirus	7 days – 3 months
Astrovirus	7 – 90 days
Coronavirus	3 hours
SARS associated virus	72 – 96 hours
Coxsackie virus	> 2 weeks
Cytomegalovirus	8 hours
Echovirus	7 days
HAV	2 hours – 60 days
HBV	> 1 week
HIV	> 7 days
Herpes simplex virus, type 1 and 2	4.5 hours – 8 weeks
Influenza virus	1 – 2 days
Norovirus and feline calici virus (FCV)	8 hours – 7 days
Papillomavirus 16	> 7 days
Papovavirus	8 days
Parvovirus	> 1 year
Poliovirus type 1	4 hours – < 8 days
Poliovirus type 2	1 day – 8 weeks
Pseudorabies virus	≥ 7 days
Respiratory syncytial virus	up to 6 hours
Rhinovirus	2 hours – 7 days
Rotavirus	6 – 60 days
Vacciniavirus	3 weeks – > 20 weeks

Kramer et al, BMC Infect Dis 2006



Pitol & Julian, Environ Sci Technol Lett 2021

Droplets & aerosols

Zayas et al. BMC Pulmonary Medicine 2012, 12:11
http://www.biomedcentral.com/1471-2466/12/11

BMC Pulmonary Medicine

RESEARCH ARTICLE Open Access

Cough aerosol in healthy participants: fundamental knowledge to optimize droplet-spread infectious respiratory disease management

Gustavo Zayas[1*], Ming C Chiang[1], Eric Wong[2], Fred MacDonald[3], Carlos F Lange[4], Ambikaipakan Senthilselvan[5] and Malcolm King[1]

Abstract

Background: The Influenza A H1N1 virus can be transmitted via direct, indirect, and airborne route to non-infected subjects when an infected patient coughs, which expels a number of different sized droplets to the surrounding environment as an aerosol. The objective of the current study was to characterize the human cough aerosol pattern with the aim of developing a standard human cough bioaerosol model for Influenza Pandemic control.

Method: 45 healthy non-smokers participated in the open bench study by giving their best effort cough. A laser diffraction system was used to obtain accurate, time-dependent, quantitative measurements of the size and number of droplets expelled by the cough aerosol.

Results: Voluntary coughs generated droplets ranging from 0.1 - 900 microns in size. Droplets of less than one-micron size represent 97% of the total number of measured droplets contained in the cough aerosol. Age, sex, weight, height and corporal mass have no statistically significant effect on the aerosol composition in terms of size

Zayas et al, BMC Pulm Med 2012

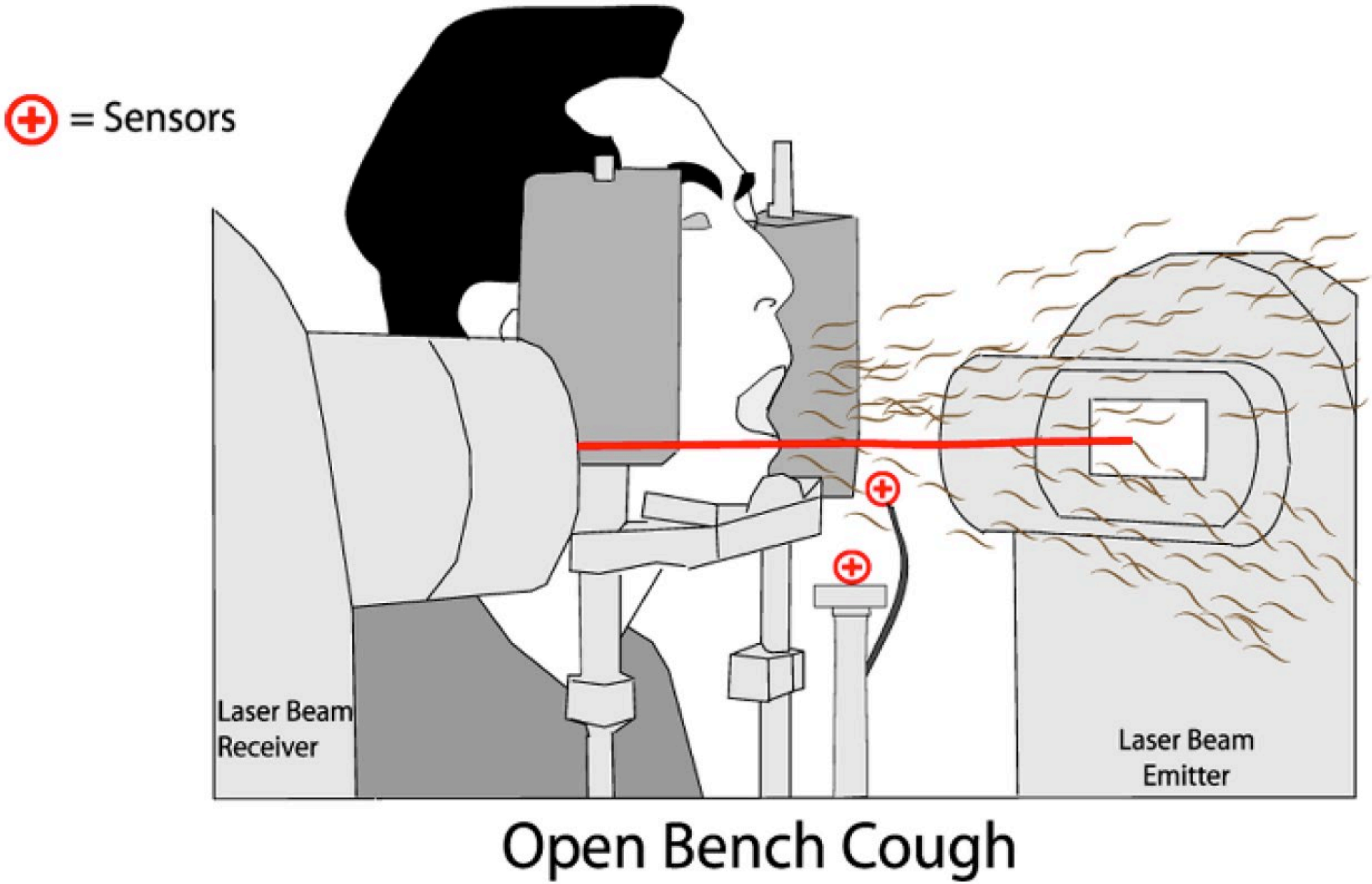


Figure 1 **Laser and sensor arrangement for Cough Aerosol detection.**

Zayas et al, BMC Pulm Med 2012

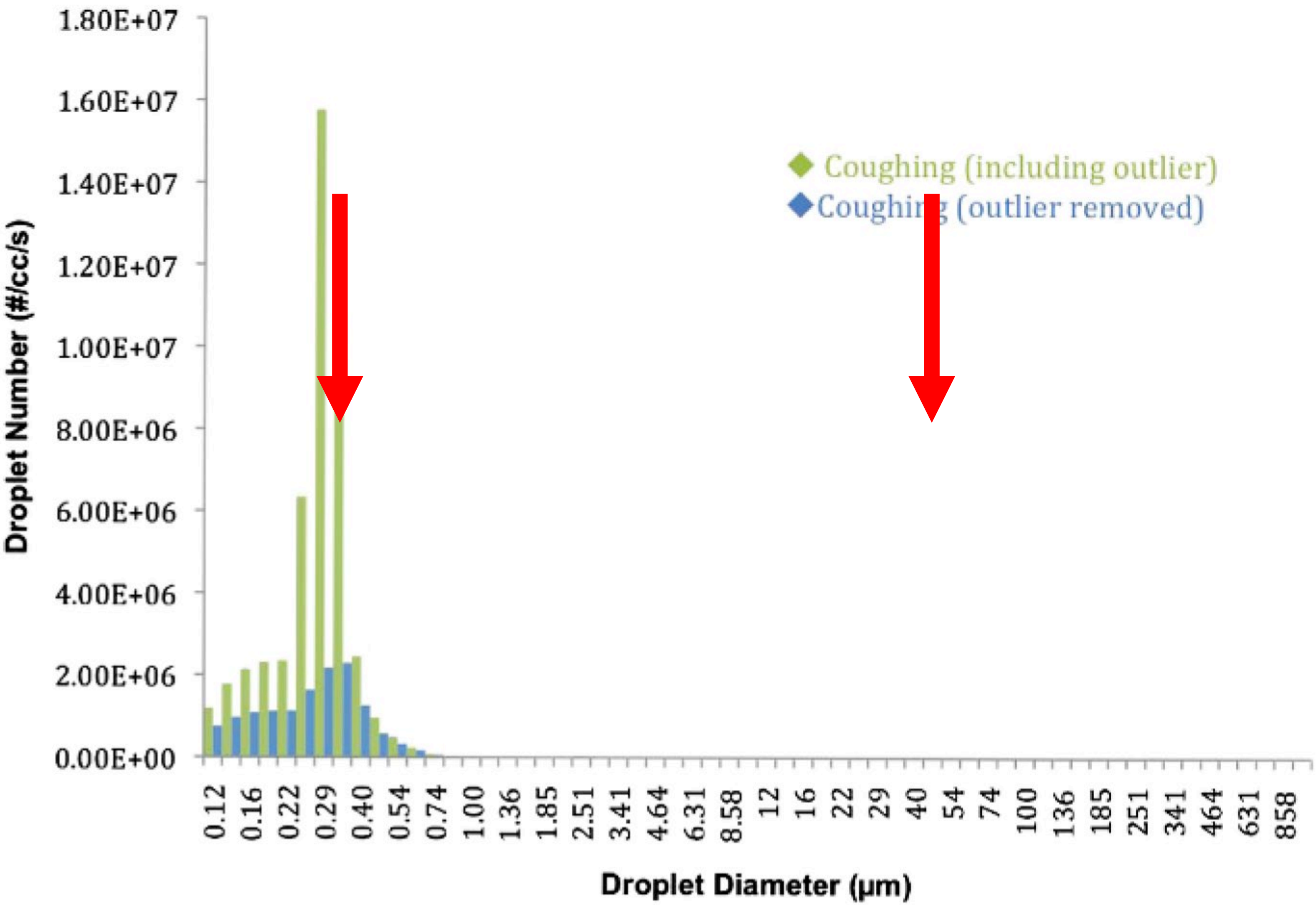


Figure 2 Full spectrum characterization of cough aerosol number versus droplets diameter per second.

Zayas et al, BMC Pulm Med 2012

CORRESPONDENCE

Visualizing Speech-Generated Oral Fluid Droplets with Laser Light Scattering

TO THE EDITOR: Aerosols and droplets generated during speech have been implicated in the person-to-person transmission of viruses,[1,2] and there is current interest in understanding the mechanisms responsible for the spread of Covid-19 by these means. The act of speaking generates oral fluid droplets that vary widely in size,[1] and these droplets can harbor infectious virus particles. Whereas large droplets fall quickly to the ground, small droplets can dehydrate and linger as "droplet nuclei" in the air, where they behave like an aerosol and thereby expand the spatial extent of emitted infectious particles.[2] We report the results of a laser light-scattering experiment in which speech-generated droplets and their trajectories were visualized.

The output from a 532-nm green laser operating at 2.5-W optical power was transformed into a light sheet that was approximately 1 mm thick and 150 mm tall. We directed this light sheet through slits on the sides of a cardboard box measuring 53 × 46 × 62 cm. The interior of the box was

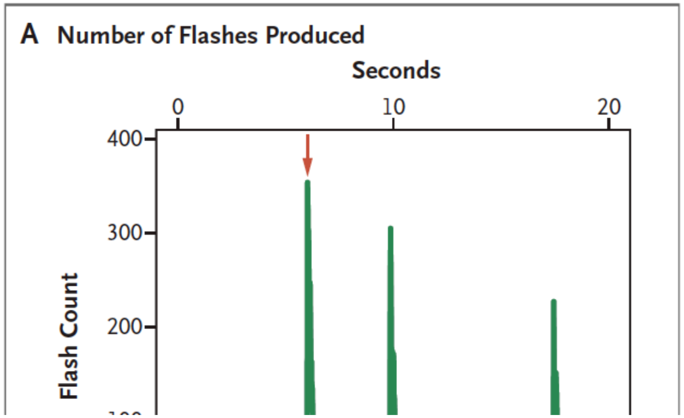
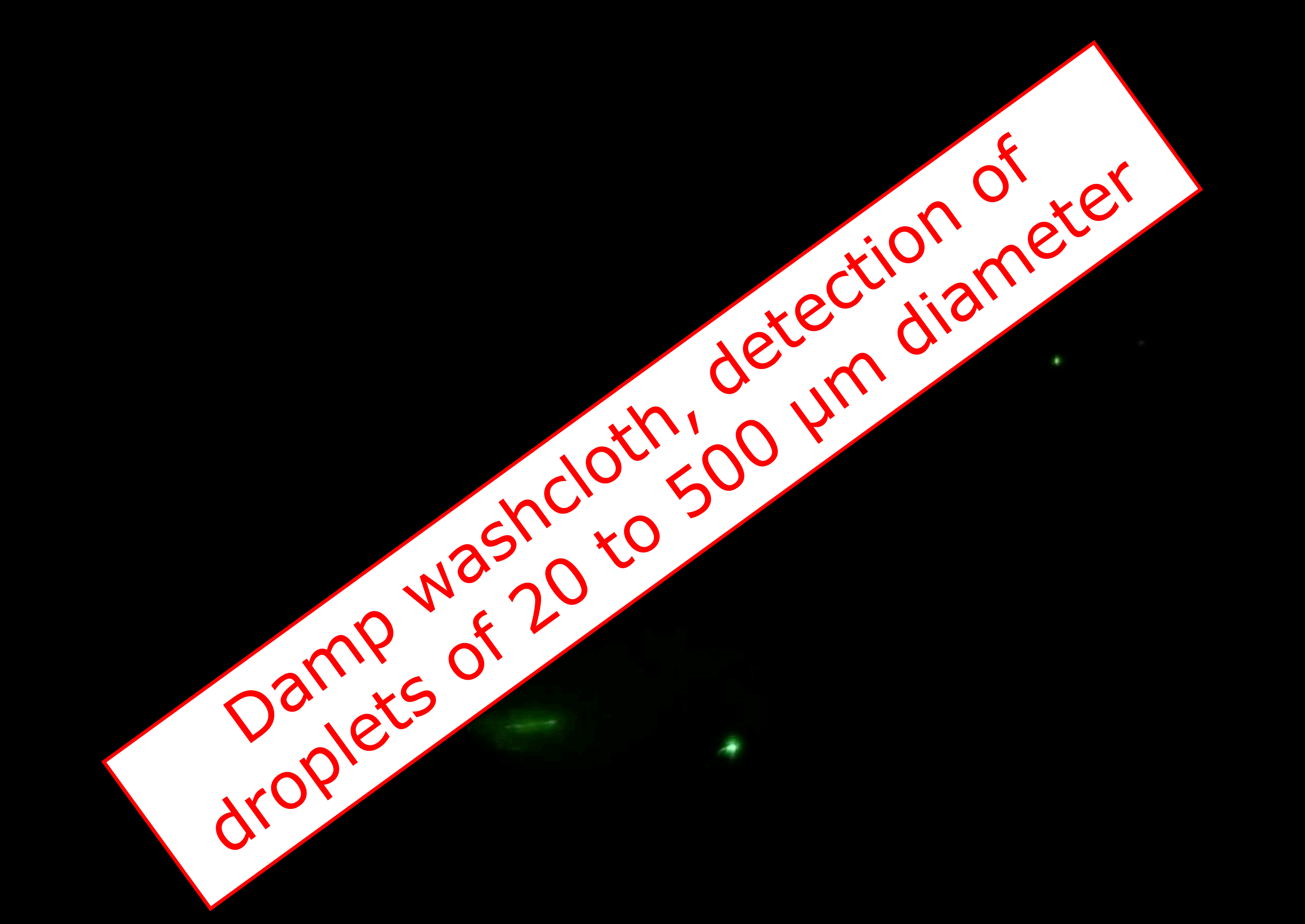


Figure 1. **Emission of Droplets While a Person Said "Stay Healthy."**

Droplets generated during speech produced flashes as they passed through the light sheet in this experiment. Panel A shows the flash count during each

Anfinrud et al, N Engl J Med 2020

Anfinrud et al, N Engl J Med 2020



Anfinrud et al, N Engl J Med 2020

JAMA Insights

Turbulent Gas Clouds and Respiratory Pathogen Emissions
Potential Implications for Reducing Transmission of COVID-19

Lydia Bourouiba, PhD

The current coronavirus disease 2019 (COVID-19) outbreak vividly demonstrates the burden that respiratory infectious diseases impose in an intimately connected world. Unprecedented containment and mitigation policies have been implemented in an effort to limit the spread of COVID-19, including travel restrictions, screening and testing of travelers, isolation and quarantine, and school closures.

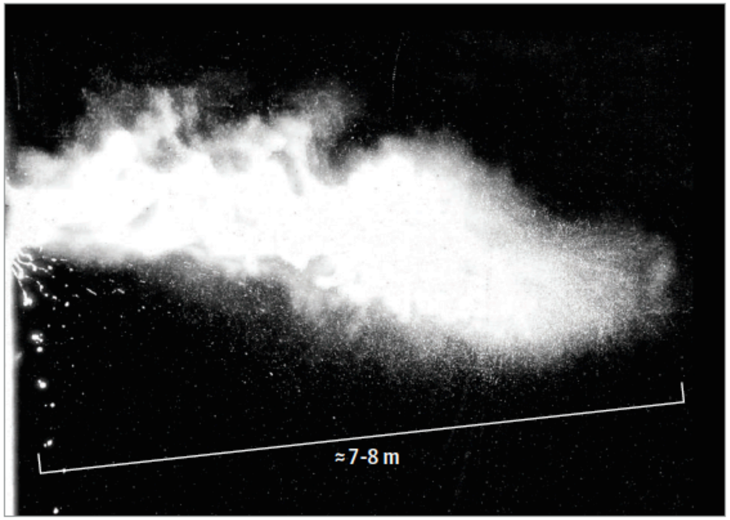
A key goal of such policies is to decrease the encounters between infected individuals and susceptible individuals and decelerate the rate of transmission. Although such social distancing strategies are critical in the current time of pandemic, it may seem surprising that the current understanding of the routes of host-to-host transmission in respiratory infectious diseases are predicated on a model of disease transmission developed in the 1930s that, by modern standards, seems overly simplified. Implementing public health recommendations based on these older models may limit the effectiveness of the proposed interventions.

+ Video

Understanding Respiratory Infectious Disease Transmission

In 1897, Carl Flügge showed that pathogens were present in expiratory droplets large enough to settle around an infected individual. "Droplet transmission" by contact with the ejected and infected fluid phase of droplets was thought to be the primary route for respiratory transmission of diseases. This view prevailed until William F. Wells focused

Figure. Multiphase Turbulent Gas Cloud From a Human Sneeze

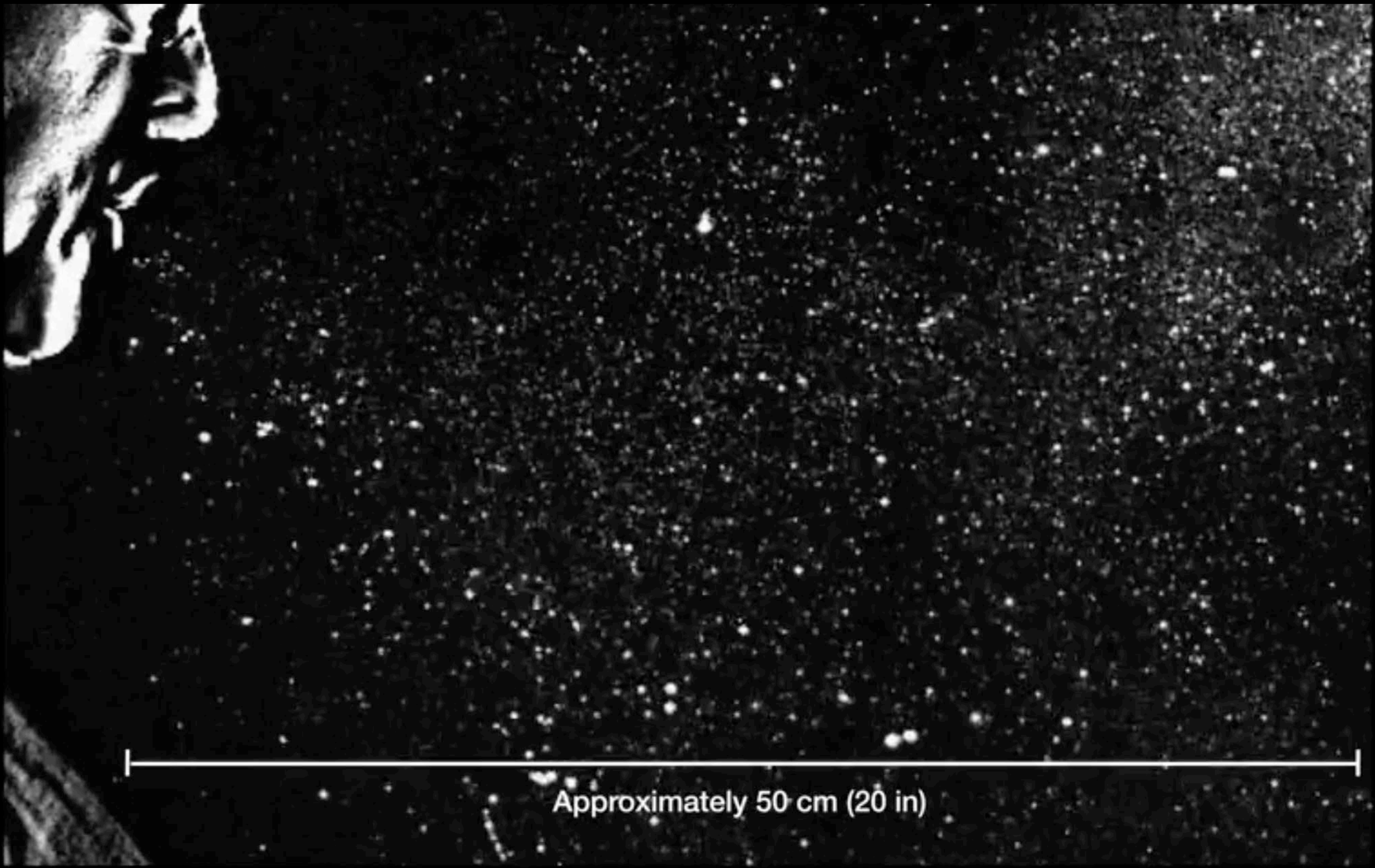


ment policies were enforced, the rapid international spread of COVID-19 suggests that using arbitrary droplet size cutoffs may not accurately reflect what actually occurs with respiratory emissions, possibly contributing to the ineffectiveness of some procedures used to limit the spread of respiratory disease.

New Model for Respiratory Emissions

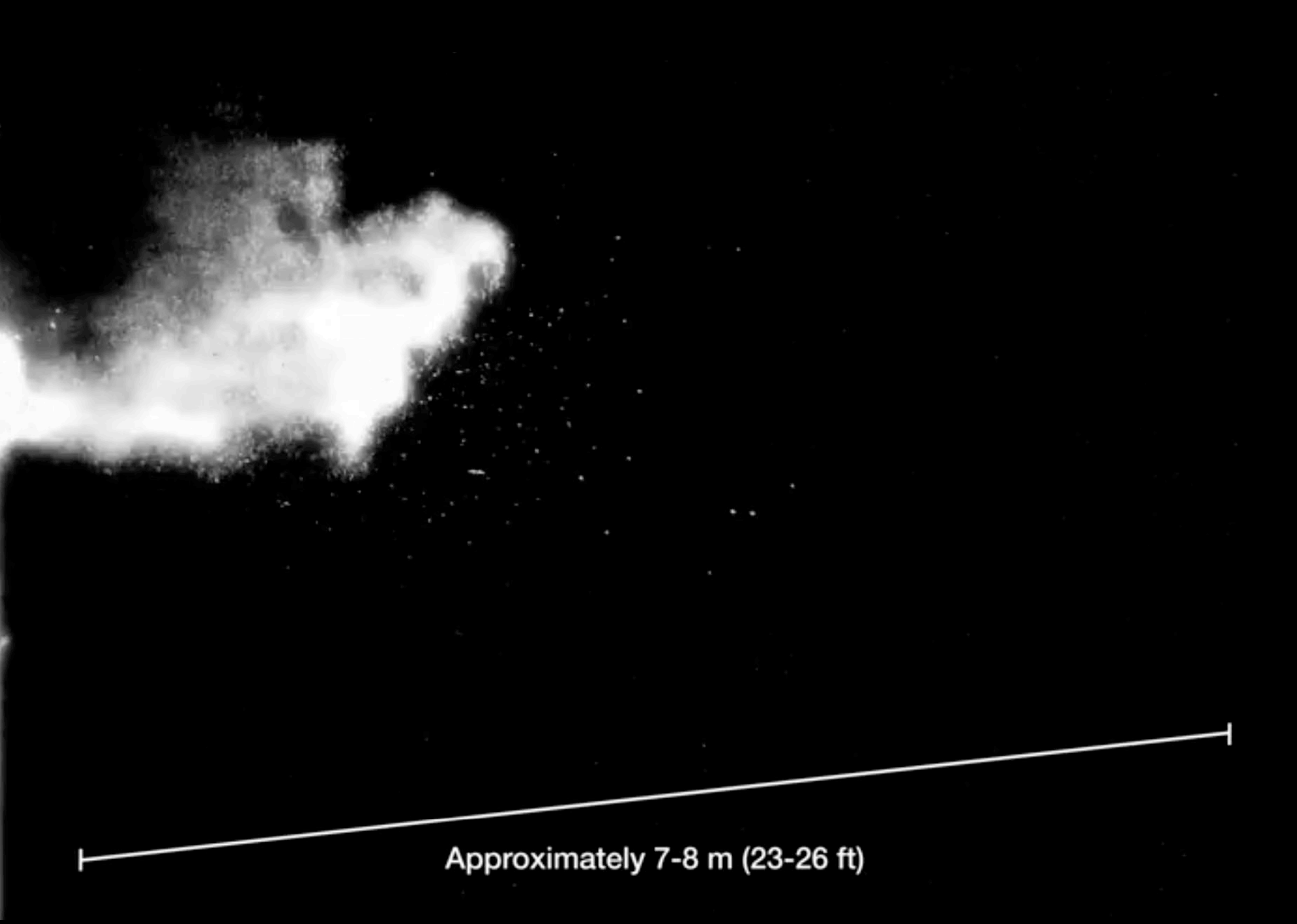
Recent work has demonstrated that exhalations, sneezes, and

Bourouiba, JAMA 2020

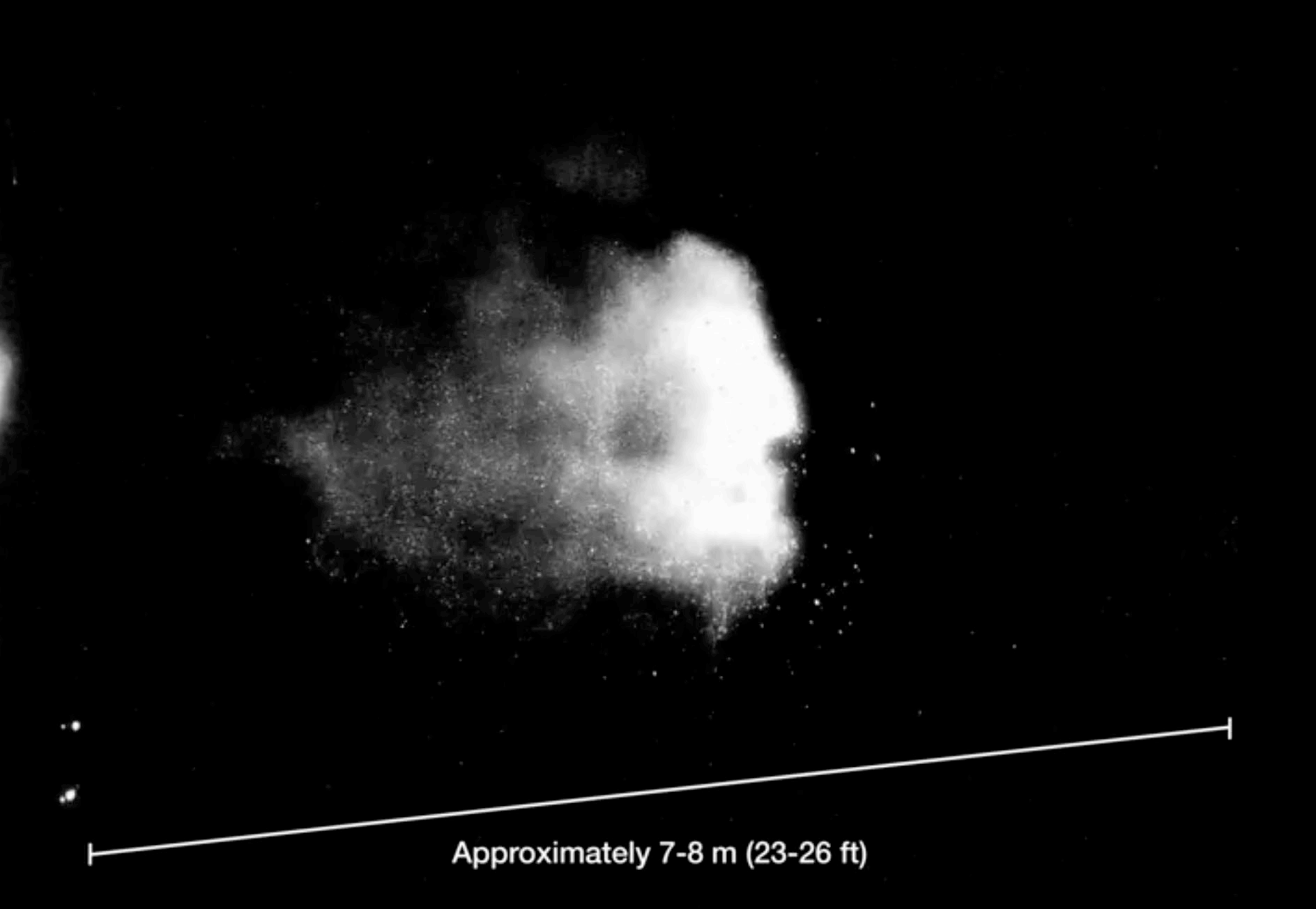


Close-up view of emission within 50 cm (20 in) from a healthy person during a violent exhalation (sneeze), originally recorded at 2000 frames per second; actual duration is 0.25 seconds

Bourouiba, JAMA 2020

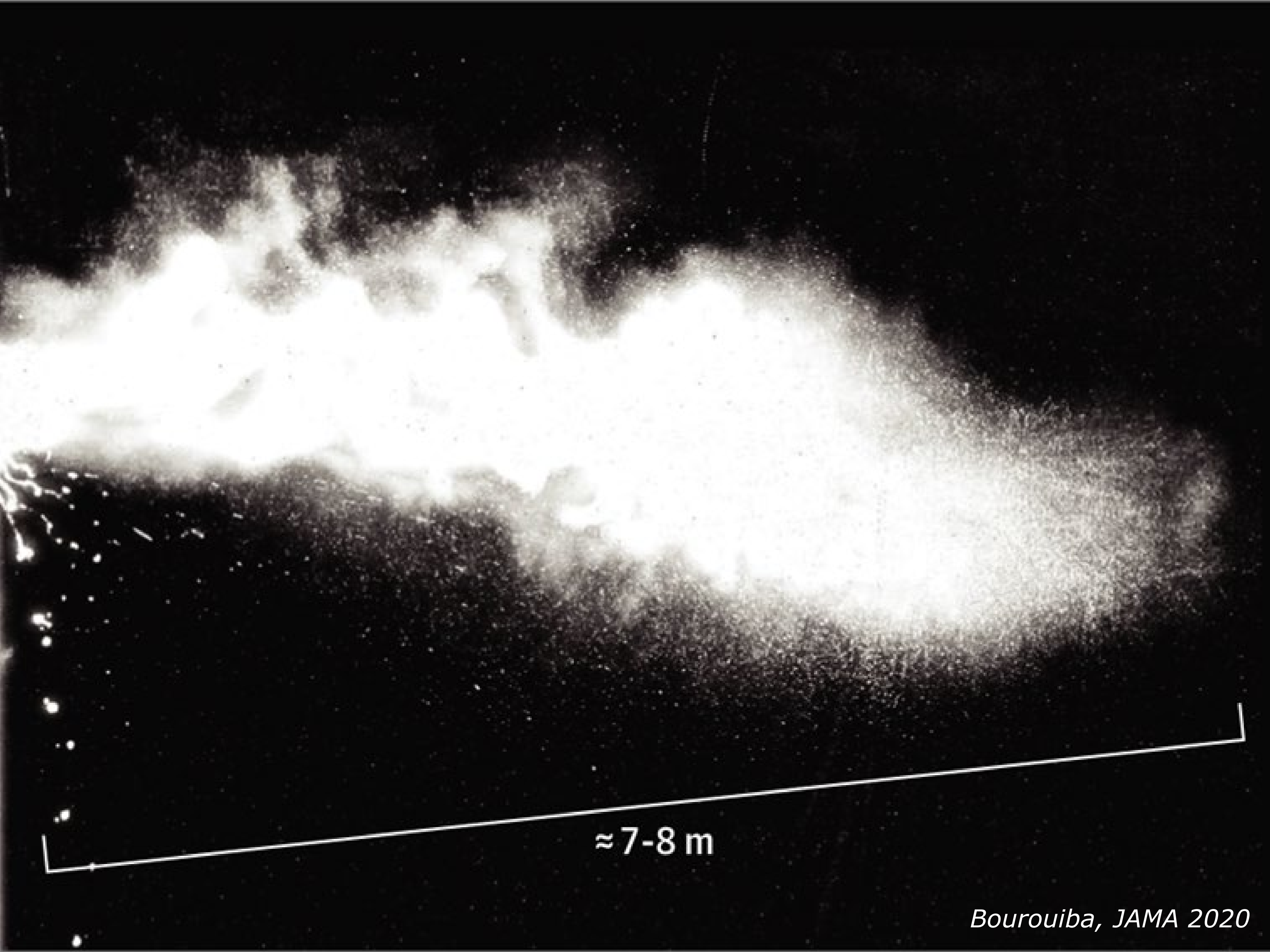


Bourouiba, JAMA 2020



Bourouiba, JAMA 2020

Bourouiba, JAMA 2020



Bourouiba, JAMA 2020

Check for updates

Infectious virus in exhaled breath of symptomatic seasonal influenza cases from a college community

Jing Yan[a,b], Michael Grantham[a,1], Jovan Pantelic[a,2], P. Jacob Bueno de Mesquita[a], Barbara Albert[a], Fengjie Liu[a,3], Sheryl Ehrman[b,4], Donald K. Milton[a,5], and EMIT Consortium[6]

[a]Maryland Institute for Applied Environmental Health, School of Public Health, University of Maryland, College Park, MD 20742; and [b]Department of Chemical and Biomolecular Engineering, Clark School of Engineering, University of Maryland, College Park, MD 20742

Edited by Peter Palese, Icahn School of Medicine at Mount Sinai, New York, NY, and approved December 15, 2017 (received for review September 19, 2017)

Little is known about the amount and infectiousness of influenza virus shed into exhaled breath. This contributes to uncertainty about the importance of airborne influenza transmission. We screened 355 symptomatic volunteers with acute respiratory illness and report 142 cases with confirmed influenza infection who provided 218 paired nasopharyngeal (NP) and 30-minute breath samples (coarse >5-µm and fine ≤5-µm fractions) on days 1–3 after symptom onset. We assessed viral RNA copy number for all samples and cultured NP swabs and fine aerosols. We recovered infectious virus from 52 (39%) of the fine aerosols and 150 (89%) of the NP swabs with valid cultures. The geometric mean RNA copy numbers were 3.8 × 10^4/30-minutes fine-, 1.2 × 10^4/30-minutes coarse-aerosol sample, and 8.2 × 10^8 per NP swab. Fine- and coarse-aerosol viral RNA were positively associated with body mass index and number of coughs and negatively associated with increasing days since symptom onset in adjusted models. Fine-aerosol viral RNA was also positively associated with having influenza vaccination for both the current and prior season. NP swab viral RNA was positively associated with upper respiratory symptoms and negatively associated with age but was not significantly associated with fine- or coarse-aerosol viral RNA or their predictors. Sneezing was rare, and sneezing and coughing were not necessary for infectious aerosol generation. Our observations suggest that influenza infection in the upper and lower airways are compartmentalized and gaps by characterizing influenza virus in exhaled breath from community-acquired influenza cases during natural breathing, prompted speech, coughing, and sneezing, and assess the infectivity of naturally occurring influenza aerosols.

Results

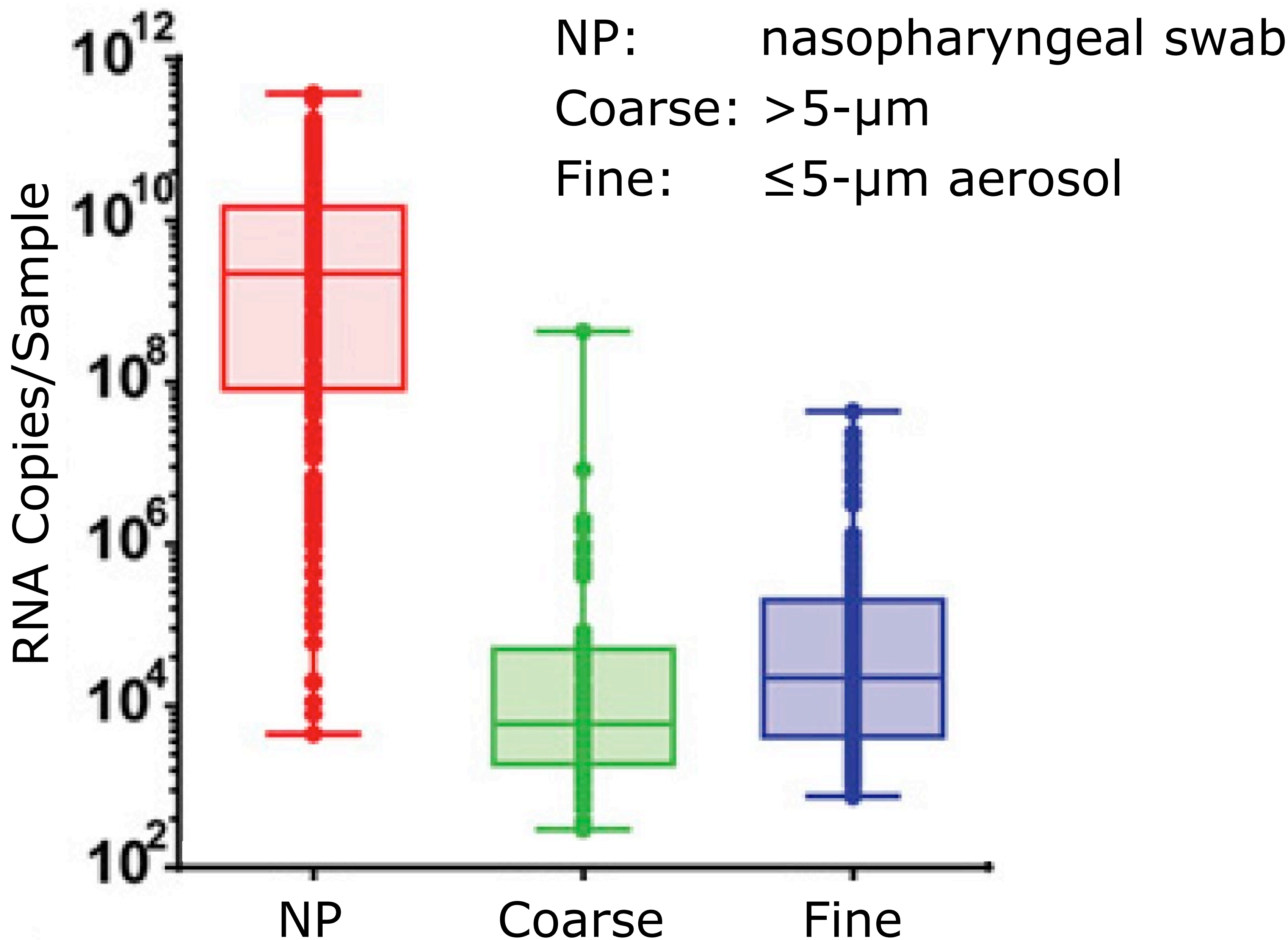
We screened 355 volunteers with acute respiratory illness; the 178 volunteers who met enrollment criteria provided 278 visits for sample collection. We confirmed influenza infection in 156 (88%) of the enrolled participants using qRT-PCR; 152 had at least one positive nasopharyngeal (NP) swab and 4 (3%) were confirmed based on positive aerosol samples alone. NP swab analysis was positive for 8 (33%) of 24 randomly selected volunteers from among the 177 screened who did not meet enrollment criteria; thus, sensitivity and specificity of our enrollment criteria, during the 2012–2013 season, were ~73% [95% confidence interval (CI) 62–84%] and 84% (95% CI 80–88%), respectively. In the reported analyses, we excluded 8 visits made on the day of symptom onset, 10 made >3 d after onset, 7 with missing data for cough, and 3 with

Significance

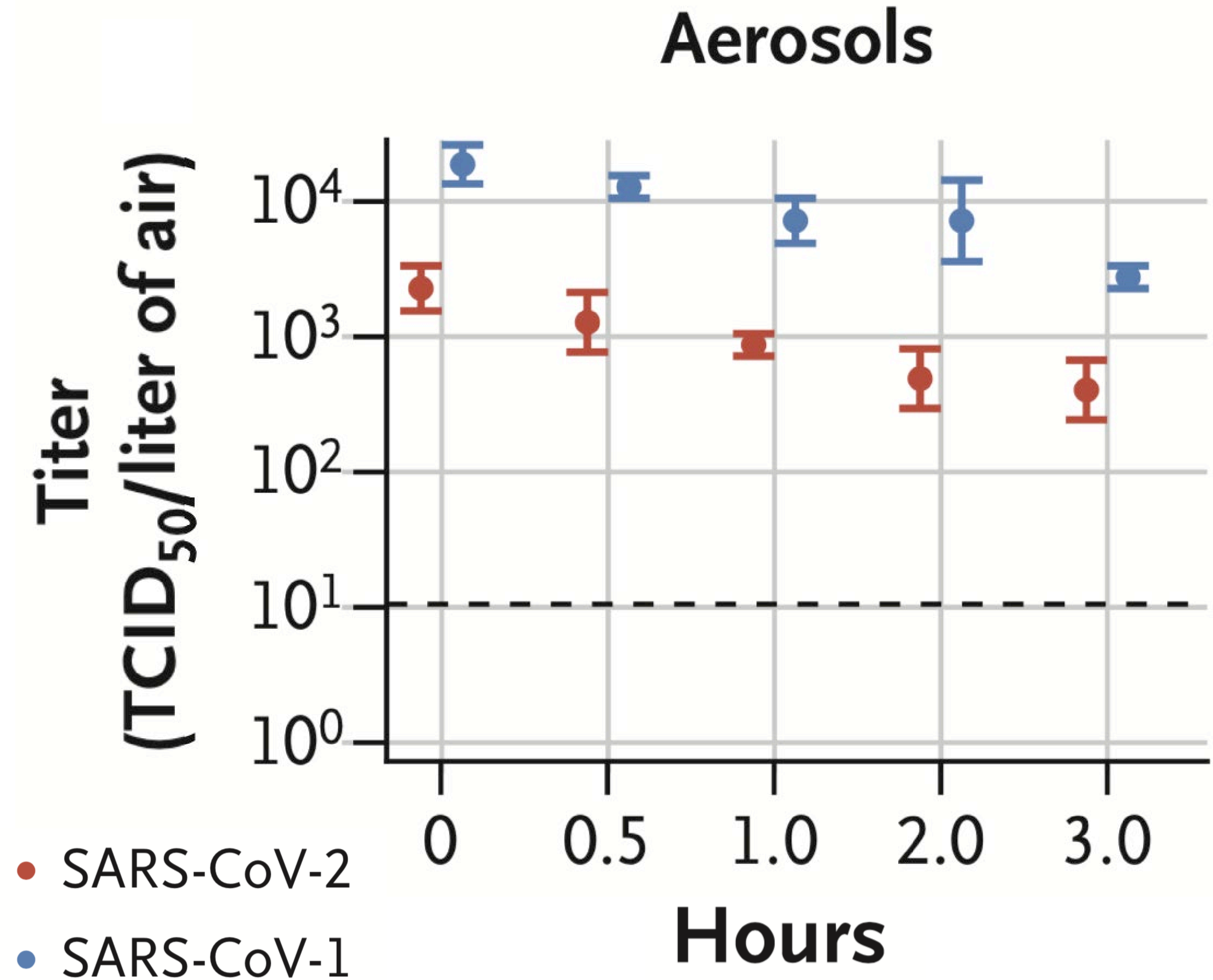
Lack of human data on influenza virus aerosol shedding fuels debate over the importance of airborne transmission. We

MICROBIOLOGY

Yan et al, Proc Natl Acad Sci U S A 2018



Yan et al, Proc Natl Acad Sci U S A 2018



van Doremalen et al, N Engl J Med 2020

OPEN ACCESS Freely available online

PLoS one

Professional and Home-Made Face Masks Reduce Exposure to Respiratory Infections among the General Population

Marianne van der Sande[1]*, Peter Teunis[1,2], Rob Sabel[3]

1 National Institute for Public Health and the Environment (RIVM), Bilthoven, Netherlands, 2 Hubert Department of Global Health, Rollins School of Public Health, Emory University, Atlanta, Georgia, United States of America, 3 Netherlands Organisation for Applied Scientific Research (TNO), Rijswijk, Netherlands

Abstract

Background: Governments are preparing for a potential influenza pandemic. Therefore they need data to assess the possible impact of interventions. Face-masks worn by the general population could be an accessible and affordable intervention, if effective when worn under routine circumstances.

Methodology: We assessed transmission reduction potential provided by personal respirators, surgical masks and home-made masks when worn during a variety of activities by healthy volunteers and a simulated patient.

Principal Findings: All types of masks reduced aerosol exposure, relatively stable over time, unaffected by duration of wear or type of activity, but with a high degree of individual variation. Personal respirators were more efficient than surgical masks, which were more efficient than home-made masks. Regardless of mask type, children were less well protected. Outward protection (mask wearing by a mechanical head) was less effective than inward protection (mask wearing by healthy volunteers).

Conclusions/Significance: Any type of general mask use is likely to decrease viral exposure and infection risk on a population level, in spite of imperfect fit and imperfect adherence, personal respirators providing most protection. Masks worn by patients may not offer as great a degree of protection against aerosol transmission.

Citation: van der Sande M, Teunis P, Sabel R (2008) Professional and Home-Made Face Masks Reduce Exposure to Respiratory Infections among the General Population. PLoS ONE 3(7): e2618. doi:10.1371/journal.pone.0002618

Editor: Madhukar Pai, McGill University, Canada

Received January 25, 2008; **Accepted** May 20, 2008; **Published** July 9, 2008

van der Sande et al, PLoS ONE 2008

Table 1. Median (IQR) protection factor by mask, by activity, by age category.

		no activity	nodding	shaking	reading	walking
Tea cloth	Adults	2.5 (2.1–2.9)	2.2 (1.9–2.5)	2.2 (1.9–2.7)	3.2 (2.5–3.9)	2.4 (2.1–3.3)
	children	2.2 (1.5–2.2)	1.9 (1.5–2.3)	1.9 (1.4–2.3)	2.2 (1.8–3.7)	2.2 (1.8–2.4)
Surgical mask	Adults	4.1 (3.1–7.2)	4.7 (3.4–7.3)	5.1 (3.2–7.6)	5.3 (4.3–8.0)	4.2 (3.1–5.7)
	children	3.2 (2.2–4.1)	3.4 (2.7–5.2)	3.6 (2.7–4.3)	4.9 (4.0–5.3)	3.6 (2.4–4.2)
FFP2 mask	Adults	113 (26–210)	82 (45–179)	91 (23–187)	66 (29–107)	99 (19–169)
	children	18 (6.1–165)	13 (3.8–41)	18 (4.0–54)	35 (8.6–91)	15 (5.1–176)

IQR = interquartile range

van der Sande et al, PLoS ONE 2008

Research

JAMA Internal Medicine | Original Investigation

Evaluation of Cloth Masks and Modified Procedure Masks as Personal Protective Equipment for the Public During the COVID-19 Pandemic

Phillip W. Clapp, PhD; Emily E. Sickbert-Bennett, PhD, MS; James M. Samet, PhD, MPH; Jon Berntsen, PhD; Kirby L. Zeman, PhD; Deverick J. Anderson, MD, MPH; David J. Weber, MD, MPH; William D. Bennett, PhD; for the US Centers for Disease Control and Prevention Epicenters Program

IMPORTANCE During the coronavirus disease 2019 (COVID-19) pandemic, the general public has been advised to wear masks or improvised face coverings to limit transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). However, there has been considerable confusion and disagreement regarding the degree to which masks protect the wearer from airborne particles.

OBJECTIVES To evaluate the fitted filtration efficiency (FFE) of various consumer-grade and improvised face masks, as well as several popular modifications of medical procedure masks that are intended to improve mask fit or comfort.

DESIGN, SETTING, AND PARTICIPANTS For this study conducted in a research laboratory between June and August 2020, 7 consumer-grade masks and 5 medical procedure mask modifications were fitted on an adult male volunteer, and FFE measurements were collected during a series of repeated movements of the torso, head, and facial muscles as outlined by the US Occupational Safety and Health Administration Quantitative Fit Testing Protocol. The consumer-grade masks tested included (1) a 2-layer nylon mask with ear loops that was tested with an optional aluminum nose bridge and filter insert in place, (2) a cotton bandana folded diagonally once (ie, "bandit" style) or in a (3) multilayer rectangle according to the instructions presented by the US Surgeon General, (4) a single-layer polyester/nylon mask with ties, (5) a polypropylene mask with fixed ear loops, (6) a single-layer polyester

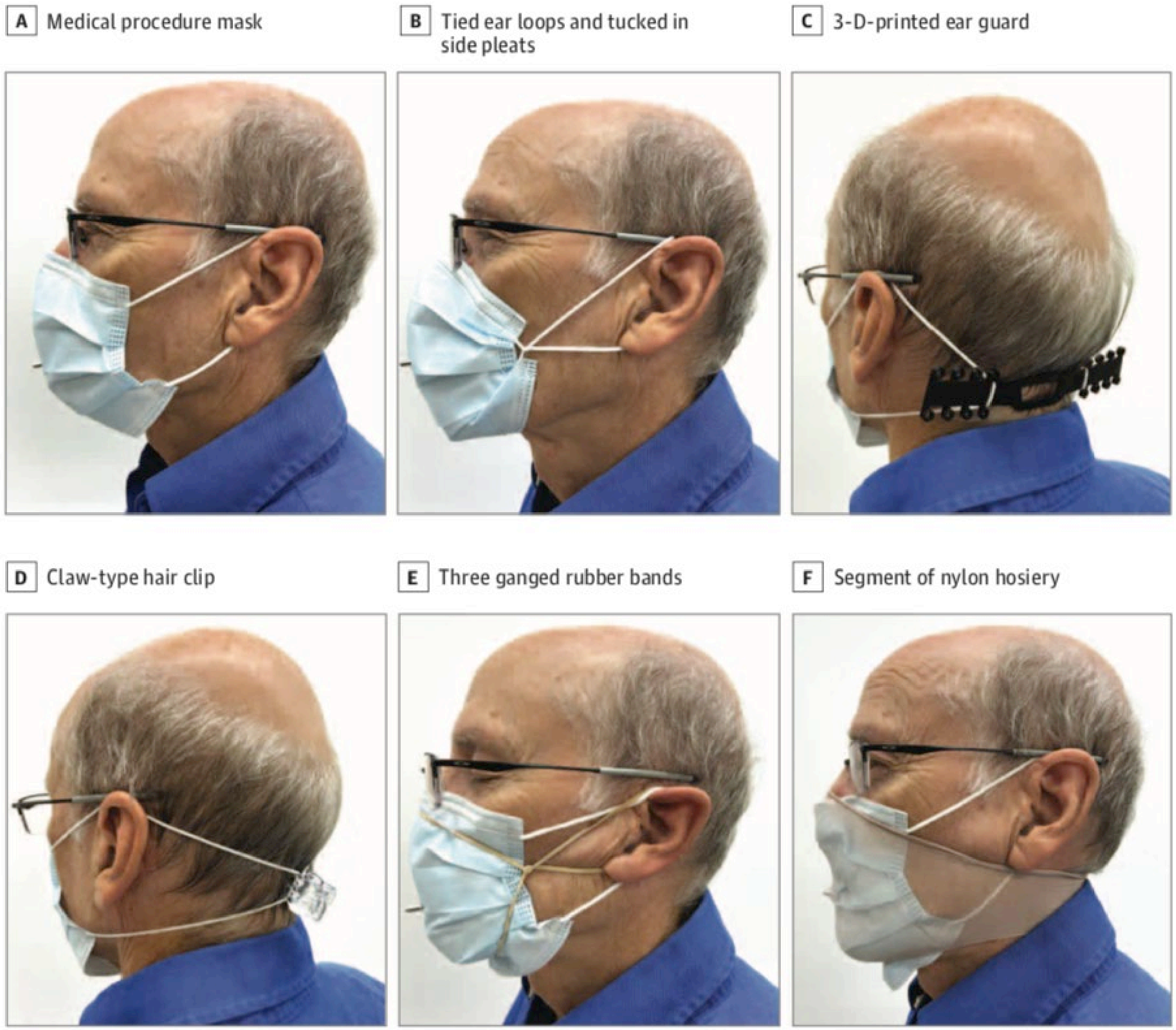
Editor's Note page 470

Clapp et al, JAMA Intern Med 2021

Figure 1. Consumer-Grade Masks and Improvised Face Coverings

Clapp et al, JAMA Intern Med 2021

Figure 2. Medical Procedure Mask and Modifications Designed to Enhance Mask Fit or Comfort for the Wearer



Clapp et al, JAMA Intern Med 2021

Table. Face Mask FFE Against Submicron Particle Penetration

Consumer-grade face masks	Condition	% FFE (SD)[a]
2-Layer nylon mask with ear loops		
Without aluminum nose bridge	New	44.7 (6.4)
With aluminum nose bridge	New	56.3 (6.5)
With aluminum nose bridge and 1 insert	New	74.4 (4.8)
With aluminum nose bridge, washed (no insert)	Washed 1 time	79.0 (4.3)
Cotton bandana		
Folded surgeon general style	New	49.9 (5.8)
Folded "bandit" style	New	49.0 (6.2)
Single-layer polyester gaiter/neck cover (balaclava bandana)	New	37.8 (5.2)
Single-layer polyester/nylon mask with ties	New	39.3 (7.2)
Polypropylene mask with fixed ear loops	New	28.6 (13.9)
3-Layer cotton mask with ear loops	New	26.5 (10.5)
Medical face masks and modifications		
3M 9210 NIOSH-approved N95 respirator	New	98.4 (0.5)
Surgical mask with ties	New	71.5 (5.5)
Procedure mask with ear loops	New	38.5 (11.2)
Procedure mask with ear loops		
Loops tied and corners tucked in	New	60.3 (11.1)
Ear guard	New	61.7 (6.5)
23-mm Claw hair clip	New	64.8 (5.1)
Fix-the-mask (3 rubber bands)	New	78.2 (3.3)
Nylon hosiery sleeve	New	80.2 (3.1)

Clapp et al, JAMA Intern Med 2021

RESEARCH LETTER

Fitted Filtration Efficiency of Double Masking During the COVID-19 Pandemic

Although global vaccination efforts against SARS-CoV-2 are underway, the public is urged to continue using face masks as a primary intervention to control transmission.[1] Recently, US public health officials have also encouraged doubling masks as a strategy to counter elevated transmission associated with infectious SARS-CoV-2 variants.[2] US Centers for Disease Control and Prevention investigators reported that doubling masks increased effectiveness, but their assessment was limited in type and combinations of masks tested, as well as by the use of head forms rather than humans. To address these limitations, this study compared the fitted filtration efficiency (FFE)[3,4] of commonly available masks worn singly, doubled, or in combinations.

Methods | Face-covering FFE was measured on 1 female volunteer (weight, 53 kg; height, 160 cm; head circumference, 56.0 cm) and 2 male volunteers with shaven faces (weight, 75 kg; height, 178 cm; head circumference, 58.5 cm; and weight, 76 kg; height, 175 cm; head circumference, 55.9 cm, respectively), as described previously.[3,4] In brief, FFE corresponds to the concentration of particles behind the mask expressed as a percentage of the particle concentration in a sodium chloride particle-enriched chamber atmosphere [FFE% = 100 × (1 − behind the mask particle concentration/ tures were 22 °C to 24 °C, and relative humidities were 42% to 52%. For the doubling of each procedure and cloth mask tested, the same mask worn singly served as a control. For all cloth-procedure mask combinations, the same procedure mask (Intco) was used for all, with the single cloth mask serving as the control. The institutional review board at the University of North Carolina at Chapel Hill waived the need for study approval as well as individual consent needed for device testing.

Results | As shown in the **Table**, procedure masks worn singly by study volunteers showed a range of mean (SD) FFE between 43% (2%) and 62% (11%). On average, across all masks and volunteers, adding a second procedure mask improved mean (SD) FFE from 55% (11%) when single masking to 66% (12%) when double masking. Single cloth masks performed less efficiently (mean [SD] FFE range, 41% [12%] to 44% [12%]) than the procedure masks. Doubling a cotton mask improved FFE but could reduce breathability.

Although adding a procedure mask (mean [SD] FFE, 61% [13%]) over the cloth masks provided modest increases in their FFE (mean [SD] range, 55% [10%] to 60% [14%]), the overall performance was no different than wearing the procedure mask by itself. In contrast, wearing a procedure mask under the cloth face covering produced marked improvements in overall FFE (mean [SD] range, 66% [5%] to 81% [6%]).

Discussion | Disposable medical procedure masks are commonly worn in health care and public settings during the

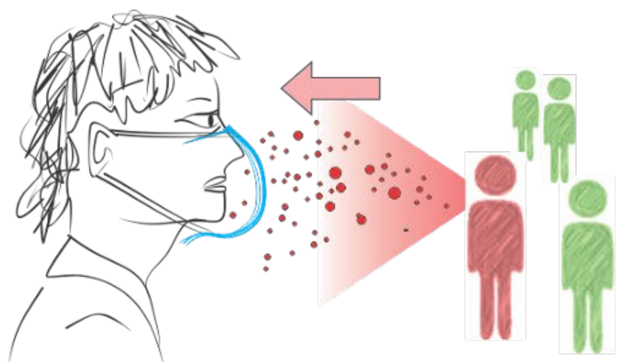
Sickbert-Bennett et al, JAMA Intern Med 2021

Table. Fitted Filtration Efficiency (FFE) of Face Masks Tested in 1 Female and 2 Male Volunteers[a]

Face mask	FFE, mean (SD), %		
	Single mask	Double mask	Difference
Procedure ear-loop masks			
Medline	53 (8)	68 (16)	14 (15)
Henry	62 (11)	74 (4)	12 (7)
Shine Ya	43 (2)	55 (10)	12 (8)
Intco	61 (13)	66 (9)	4 (12)
Cloth masks			
Hanes cotton ear-loop mask	44 (12)	57 (14)	14 (4)
Procedure mask worn over	NA	59 (18)	16 (10)
Procedure mask worn under	NA	66 (5)	23 (12)
Cotton bandana	44 (4)	NA	NA
Procedure mask worn over	NA	55 (10)	11 (8)
Procedure mask worn under	NA	77 (10)	33 (10)
Polyester gaiter	41 (12)	NA	NA
Procedure mask worn over	NA	60 (14)	19 (7)
Procedure mask worn under	NA	81 (6)	40 (6)

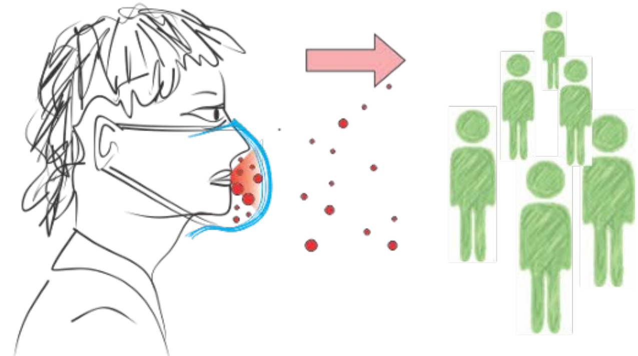
Sickbert-Bennett et al, JAMA Intern Med 2021

protecting yourself
(inward protection)



	particles leaked through mask	particles produced in environment
TEA CLOTH (home made)	33	100 (reference value)
SURGICAL MASK	25	
FFP2 (=N95 equivalent)	1	

protecting others
(outward protection)



particles produced by coughing	particles leaked into environment
100 (reference value)	90
	50
	30

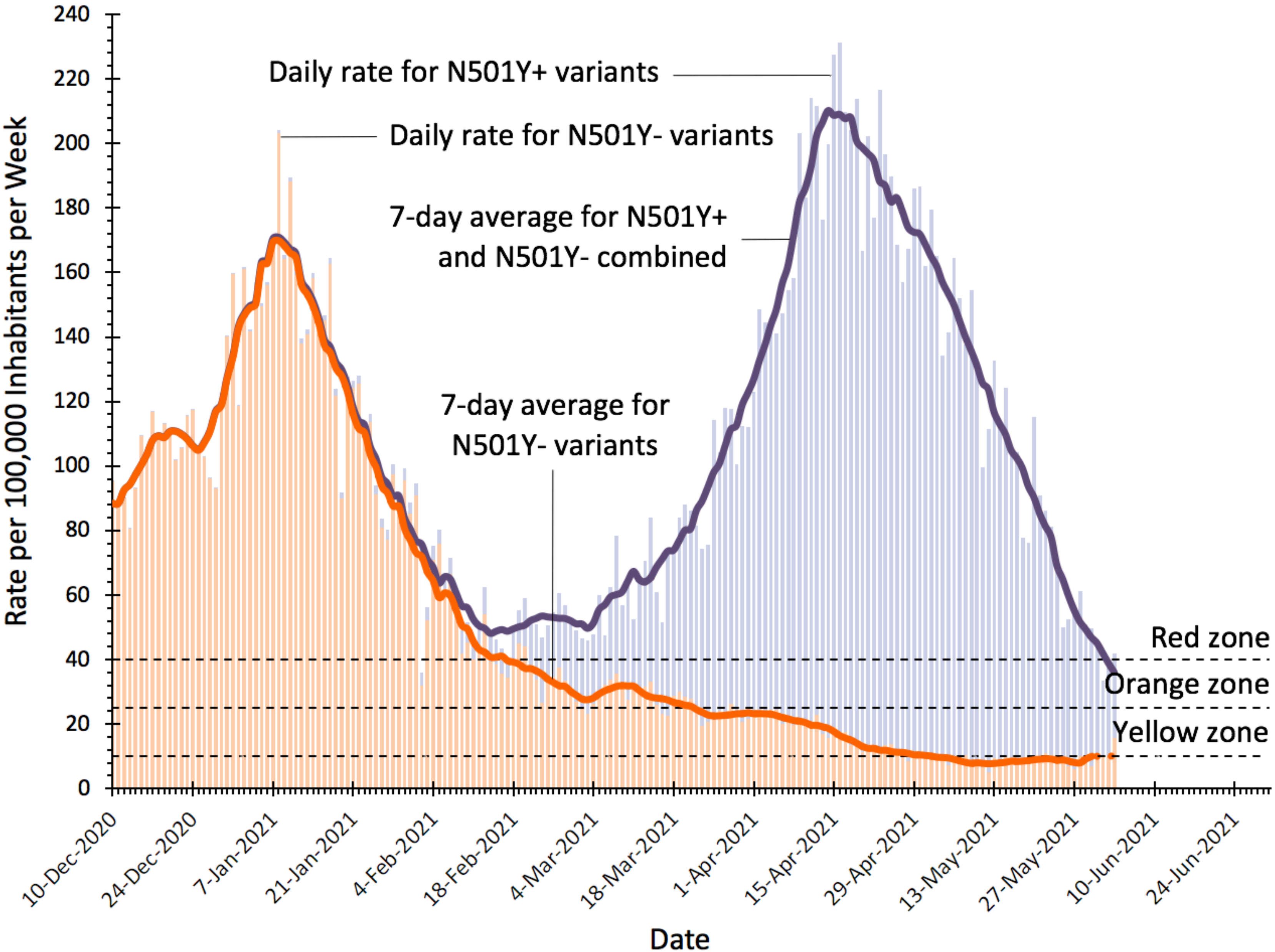
https://medium.com/@Cancerwarrior/covid-19-why-we-should-all-wear-masks-there-is-new-scientific-rationale-280e08ceee71 - Calculated from van der Sande et al, PLoS ONE 2008

10 Reasons in Support of Role of Aerosols in Transmission

1	**Superspreading events with long-range SARS-CoV-2 transmission** Superspreading events on cruise ships, concert choirs, correctional facilities etc. where individuals are often spread far apart, in a contained environment suggest airborne transmission
2	**SARS-CoV-2 transmission between adjacent rooms** Outbreaks in apartment buildings and hotels between individuals who have not come in contact with one another, but have shared a ventilation system suggest airborne transmission
3	**Asymptomatic and presymptomatic SARS-CoV-2 transmission** Absence of coughing and sneezing in asymptomatic and presymptomatic transmission suggests potential airborne transmission
4	**Higher levels of transmission indoors, as compared to outdoors** The overwhelming majority of SARS-CoV-2 outbreaks happened indoors
5	**Nosocomial infections in the presence of PPEs that protect against droplet transmission**
6	**Detection of infectious SARS-CoV-2 in the air for up to 3 hours**
7	**Presence of SARS-CoV-2 in air filters and air ducts in hospitals with COVID-19 patients** SARS-CoV-2 in these locations could have only occurred via airborne transmission
8	**Experimental evidence** Studies involving infected caged animals that were connected to separately caged uninfected animals via an air duct have shown transmission of SARS-CoV-2 that can be adequately explained only by aerosols
9	**No strong or consistent evidence against airborne transmission** No study has provided strong or consistent evidence to refute the hypothesis of airborne SARS-CoV-2 transmission
10	**Limited evidence for other dominant routes of transmission** Ease of infection between people in close proximity can be due to either airborne transmission or due to respiratory droplet transmission of SARS-CoV-2.

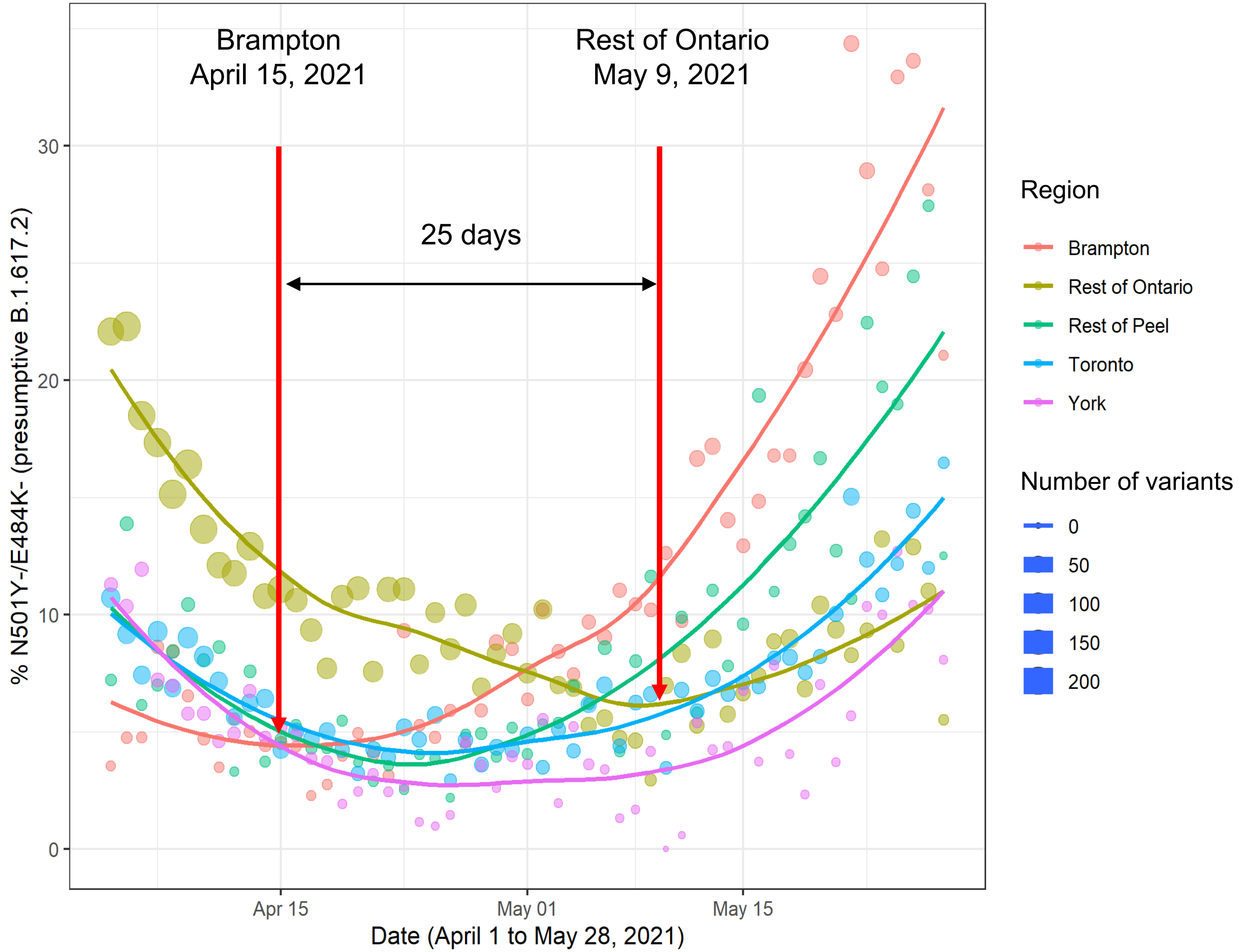
Adapted from Greenhalgh et al, Lancet 2021

Delta (B1.617.2)

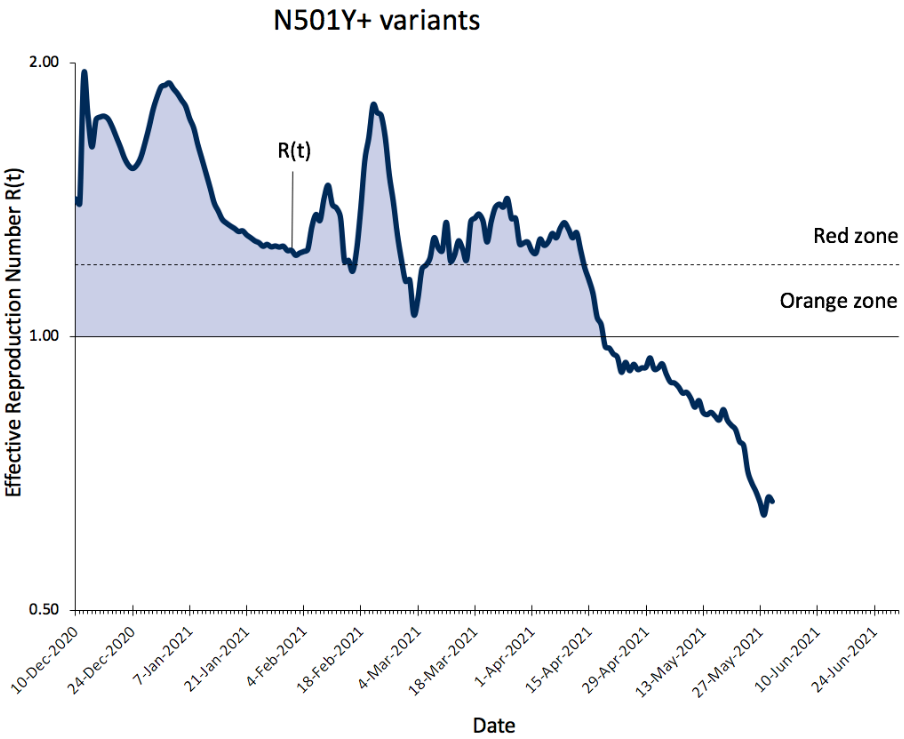


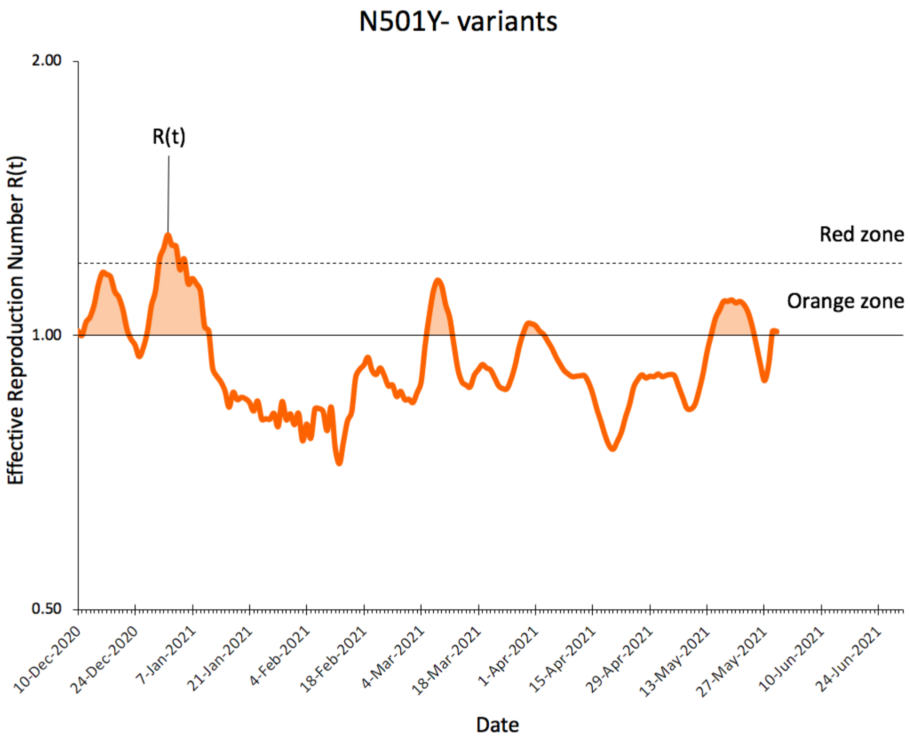
https://covid19-sciencetable.ca/ontario-dashboard/

Inflection point: 50% of N501Y-likely are Delta-variants



Brown K (personal communication)


N501Y+ variants
2.00
1.00
0.50
Effective Reproduction Number R(t)
R(t)
Red zone
Orange zone
10-Dec-2020
24-Dec-2020
7-Jan-2021
21-Jan-2021
4-Feb-2021
18-Feb-2021
4-Mar-2021
18-Mar-2021
1-Apr-2021
15-Apr-2021
29-Apr-2021
13-May-2021
27-May-2021
10-Jun-2021
24-Jun-2021
Date


N501Y- variants
2.00
1.00
0.50
Effective Reproduction Number R(t)
R(t)
Red zone
Orange zone
10-Dec-2020
24-Dec-2020
7-Jan-2021
21-Jan-2021
4-Feb-2021
18-Feb-2021
4-Mar-2021
18-Mar-2021
1-Apr-2021
15-Apr-2021
29-Apr-2021
13-May-2021
27-May-2021
10-Jun-2021
24-Jun-2021
Date

Increased transmissibility

	R_0	Increase
Wild type (Wuhan)	2.2	-
B.1.1.7 (UK)	3.3	x 1.5
B.1.617 (India)	5.0	x 1.5

Vaccine Effectiveness larger after 2nd dose for Delta, larger after 1st dose for Alpha

	VE	RR
Alpha (B1.1.7.)		
1st dose	70%	0.30
1st & 2nd dose	90%	0.10
Added effectiveness of 2nd dose	33%	0.10/0.30
Delta (B1.617.2)		
1st dose	40%	0.60
1st & 2nd dose	90%	0.10
Added effectiveness of 2nd dose	83%	0.10/0.60

Data partially from Bernal et al, medRxiv 2021

Conclusions

- 4 plausible routes of transmission
  - Individual contribution depends on the setting and is difficult to quantify
- Aerosol transmission is a relevant route
  - Safety measures in the community include being outdoors, good ventilation, low occupancy, 2 meters distance, well-fitting masks of high quality
- Indirect contact may be a relevant route in high prevalence settings
  - Hand hygiene, but not necessarily surface disinfection useful in the presence of reasonable cleaning protocols
- Delta will become dominant in Ontario
  - We can ‘vaccinate ourselves out of a fourth wave’
  - Unvaccinated people have a high probability to get infected in the future