Size of Aerosol Particles Containing Respiratory Viruses

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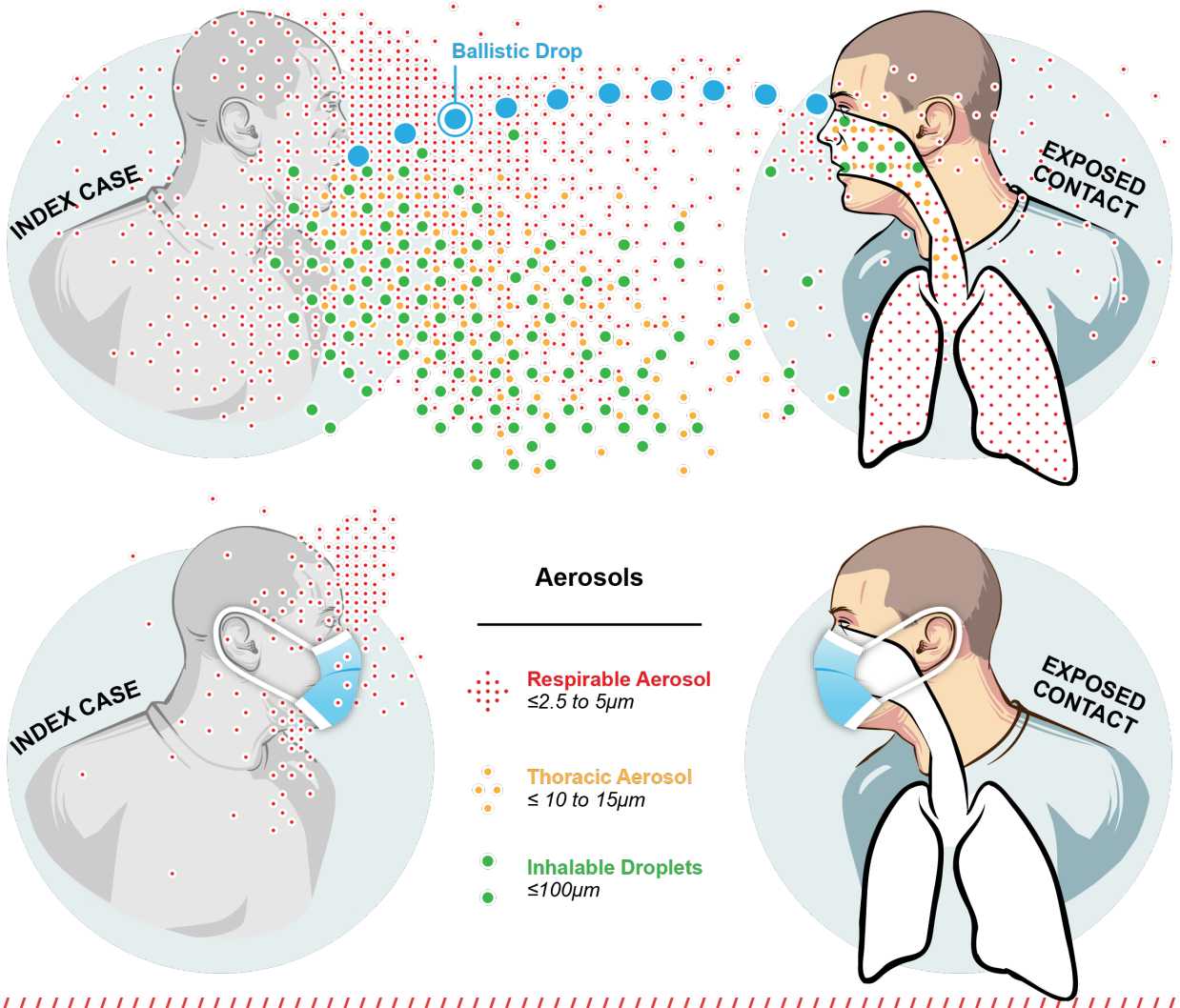
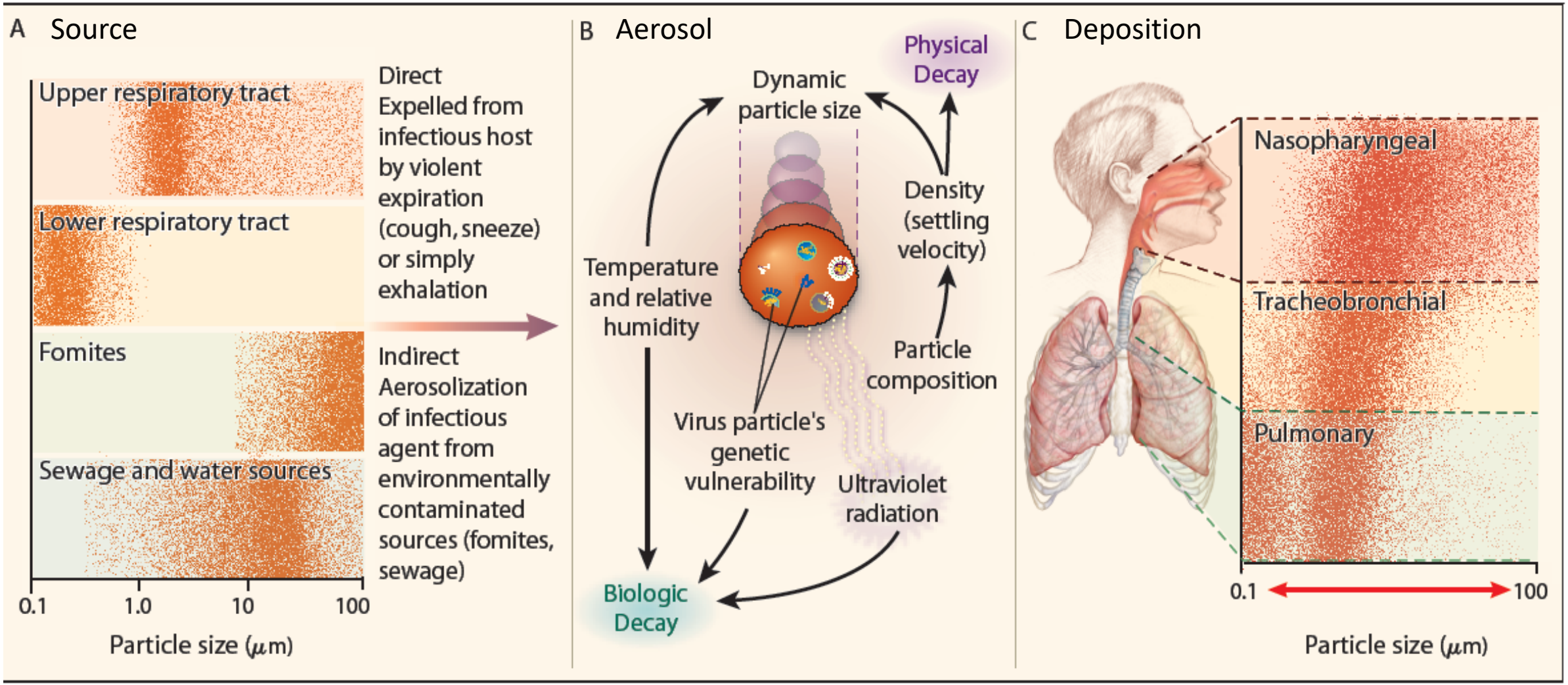
Transmission Modes of Respiratory Viruses

- Contact (direct and indirect)
  - Case to finger of contact
  - Fomite to finger of contact
  - Finger to eye, nose, or mouth
- Sprayborne
  - Ballistic drops (> 100 µm)
  - Direct hit on eye, nostril, or mouth
- Aerosol inhalation
  - Nasopharyngeal (Inhalable) ≤ 100 µm
  - Thoracic ≤ 10-15 µm
  - Respirable ≤ 5 µm



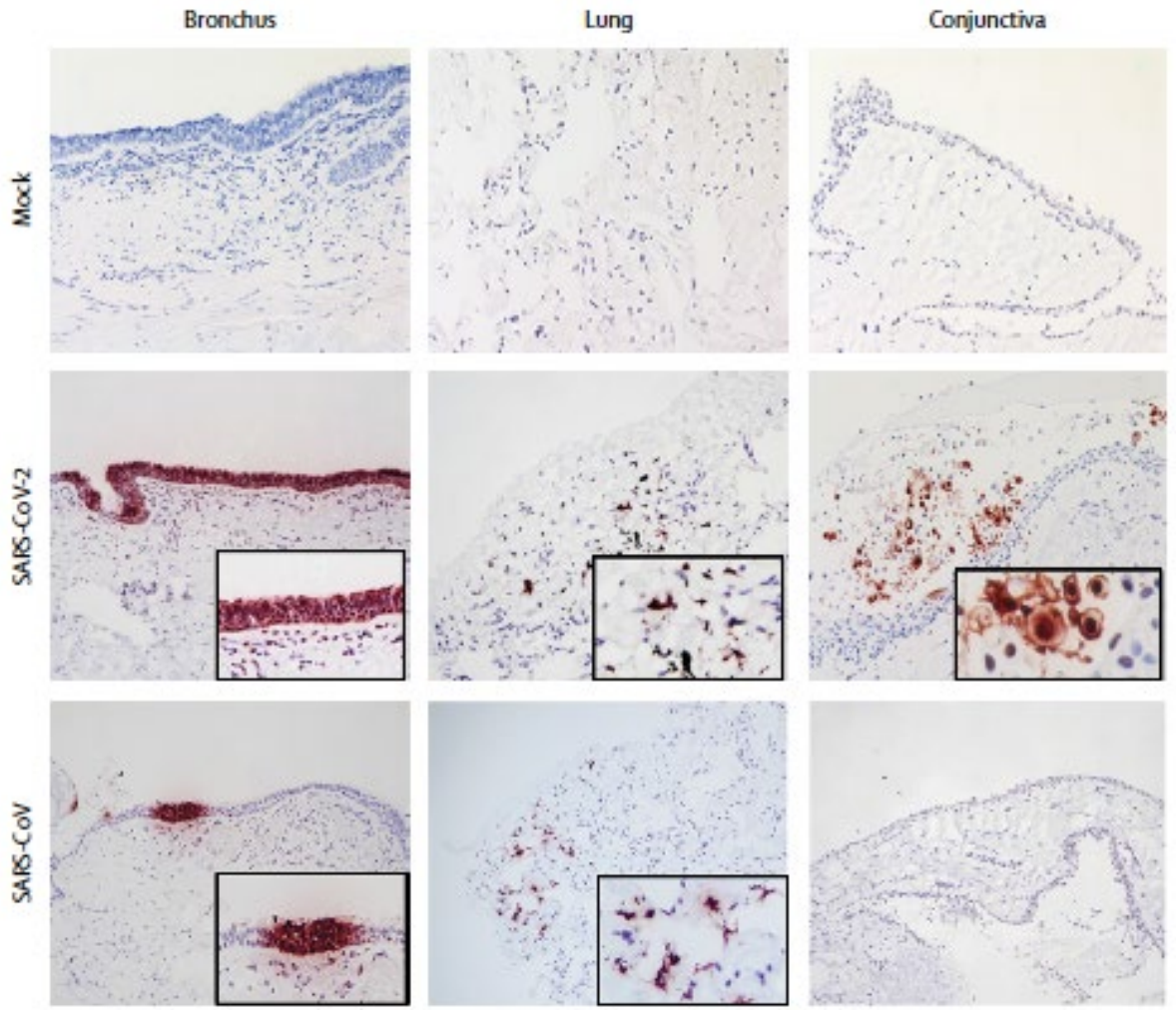
D. K. Milton, *J Pediatric Infect Dis Soc* (2020), doi:10.1093/jpids/piaa079.

Total & Regional Respiratory Tract Deposition of Aerosols



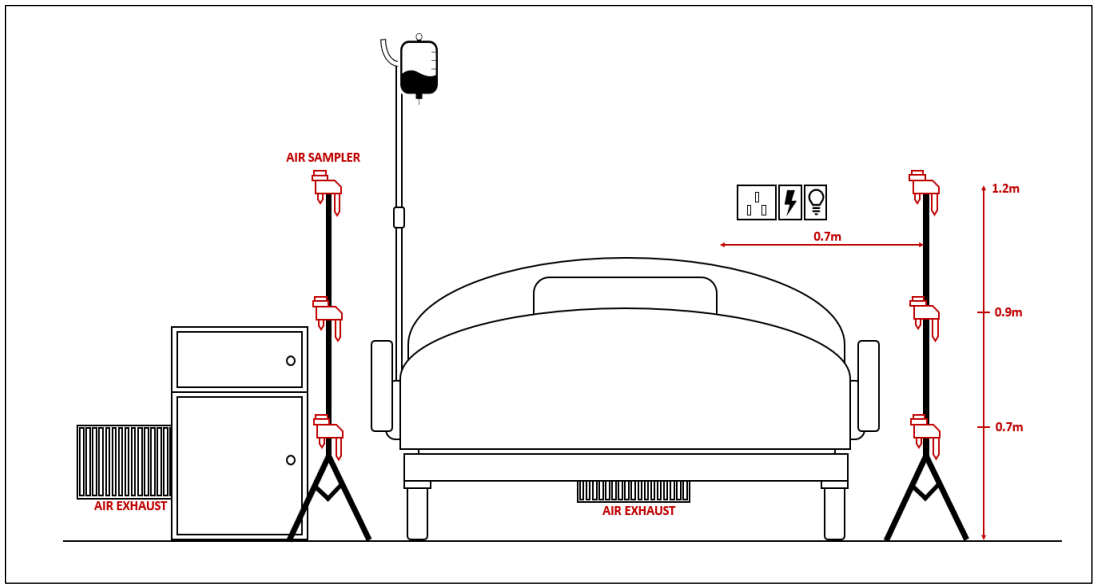
Roy C and Milton DK, New Engl J Med, 2004

Where Do SARS-CoV-2 Viruses Bind and Infect?



K. P. Y. Hui *et al.*, *Lancet Respir Med* (2020), doi:10.1016/S2213-2600(20)30193-4.

SARS-CoV-2 Aerosols in Containment Unit, Singapore

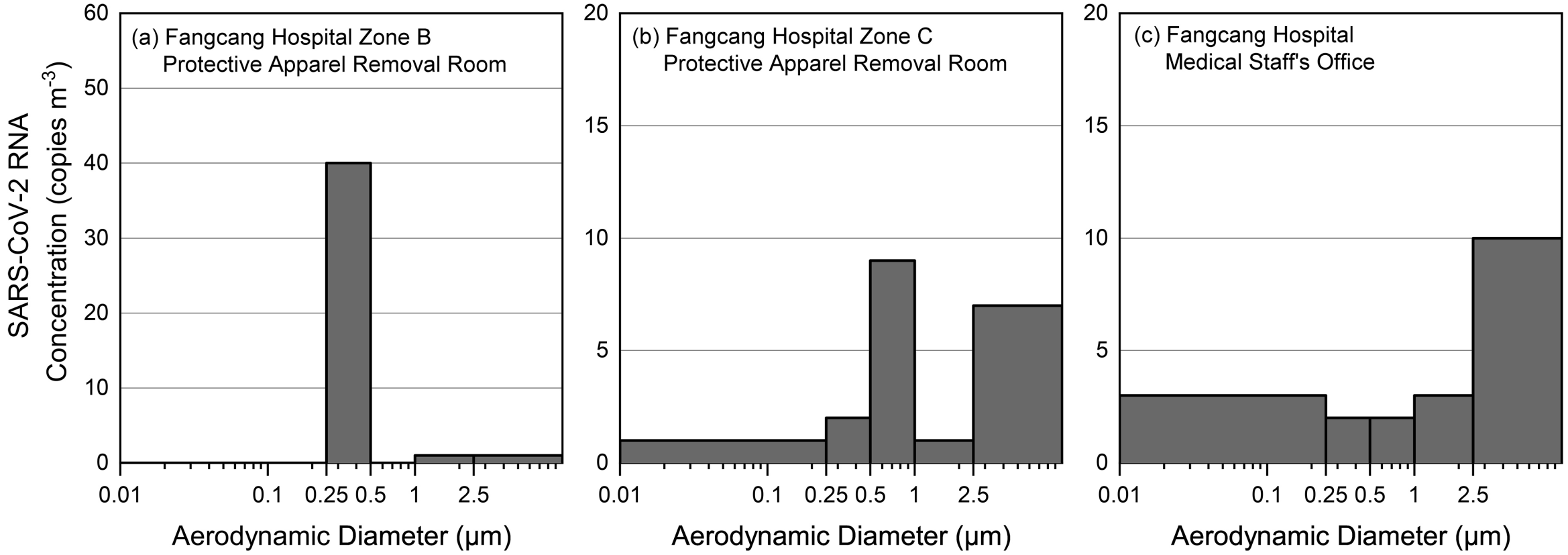


Patient	Day of illness	Symptoms reported on day of air sampling	Clinical Ct value*	Airborne SARS-CoV-2 concentrations (RNA copies m^{-3} air)	Aerosol particle size	Samplers used
1	9	Cough, nausea, dyspnea	33.22	ND ND	-- --	NIOSH SKC Filters
2	5	Cough, dyspnea	18.45	2,000 1,384	>4 µm 1-4 µm	NIOSH
3	5	Asymptomatic†	20.11	927 916	>4 µm 1-4 µm	NIOSH

Average breathing rate ~12-14 m^3 per day

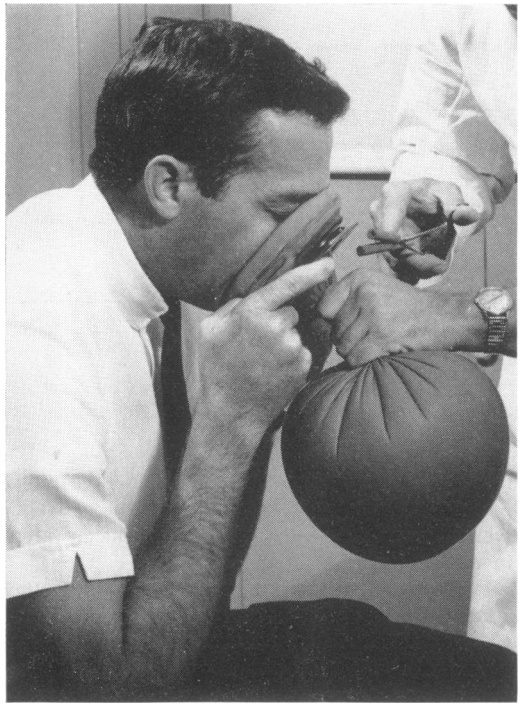
P. Y. Chia *et al.*, *Nature Communications*. **11**, 2800 (2020).

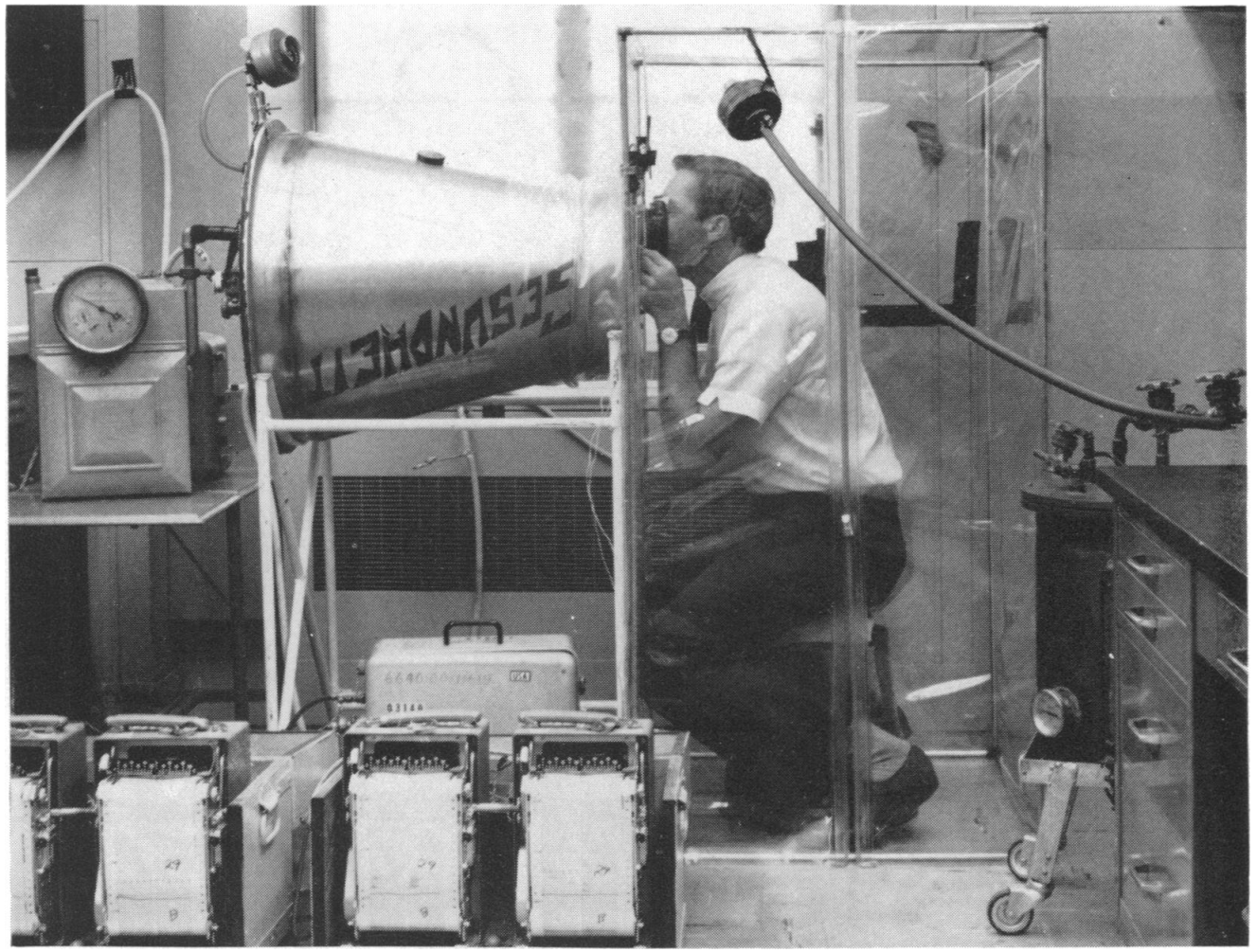
Aerodynamic analysis of SARS-CoV-2 in two Wuhan hospitals



Y. Liu *et al.*, *Nature*, 1–6 (2020).

Human Cough and Sneeze Collectors 1960s

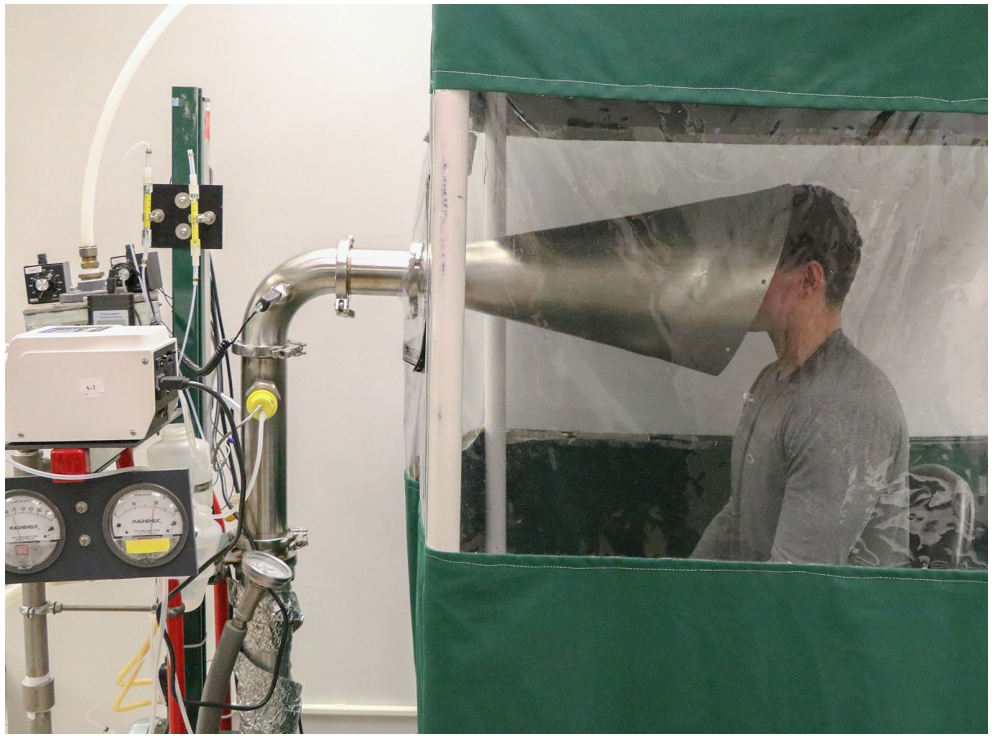




Gerone PJ, Couch RB, Keefer GV, Douglas RG, Derrenbacher EB, Knight V. Bacteriol Rev. 1966 Sep;30(3):576–88.

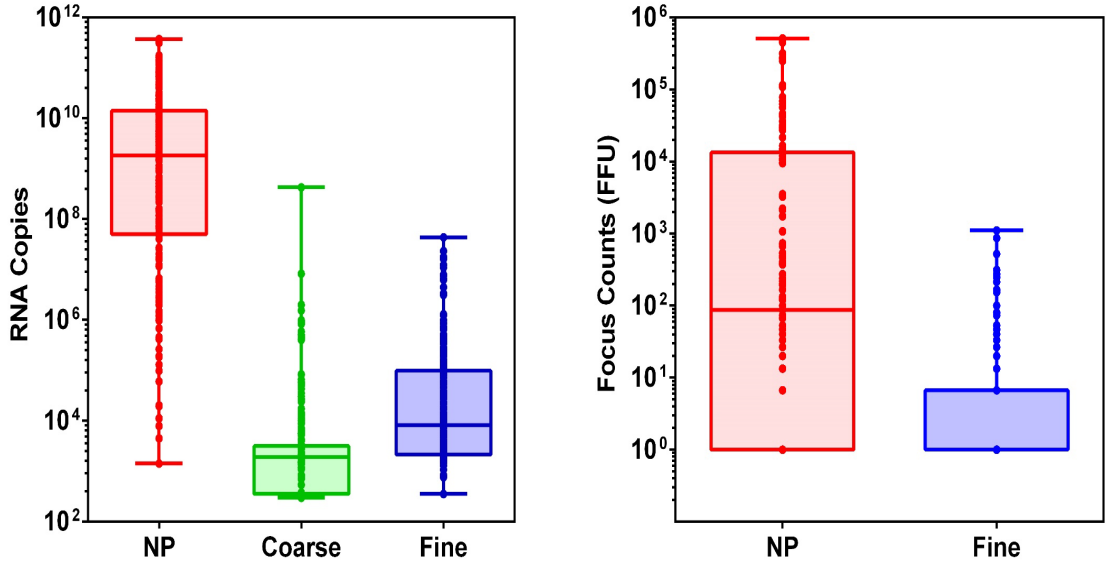
Gesundheit-II Human Bioaerosol Collector

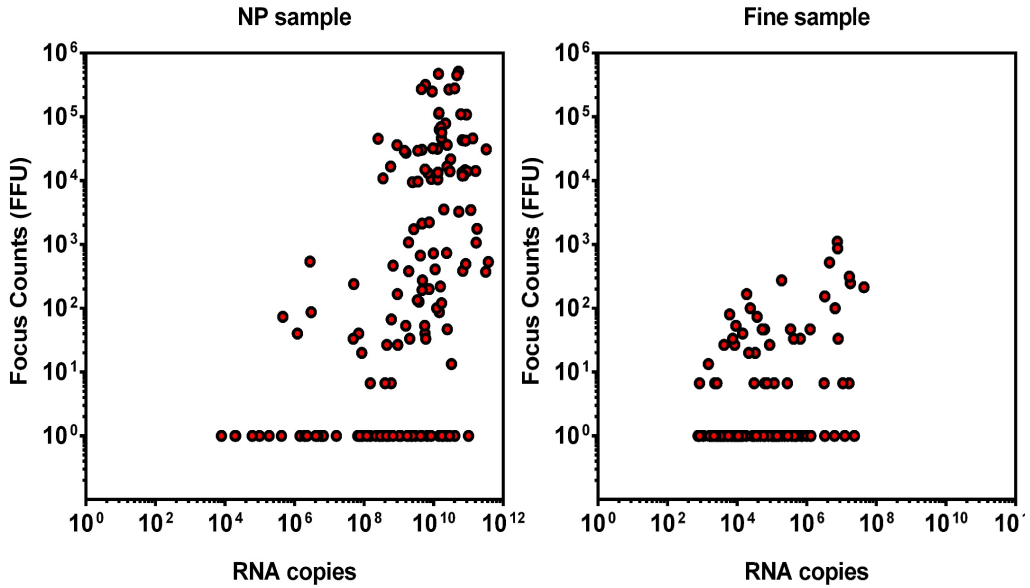
- Capture hood over subject's face
  - Natural breathing
  - No mouthpiece, forced cough, or forced breathing patterns
- 30-min sample
- Recitation of alphabet at 5, 15, & 25 min.
- Count audible spontaneous coughs & sneezes
- Coarse particles > 5.0 µm
  - Dry Teflon® impactor substrate
- Fine particles ≤ 5 µm and > 0.05 µm
  - Phosphate buffer with BSA



J. J. McDevitt *et al.*, *Aerosol Sci Technol*. **47**, 444–451 (2013).

Influenza Virus RNA & Culturable Virus in Swabs and Aerosols



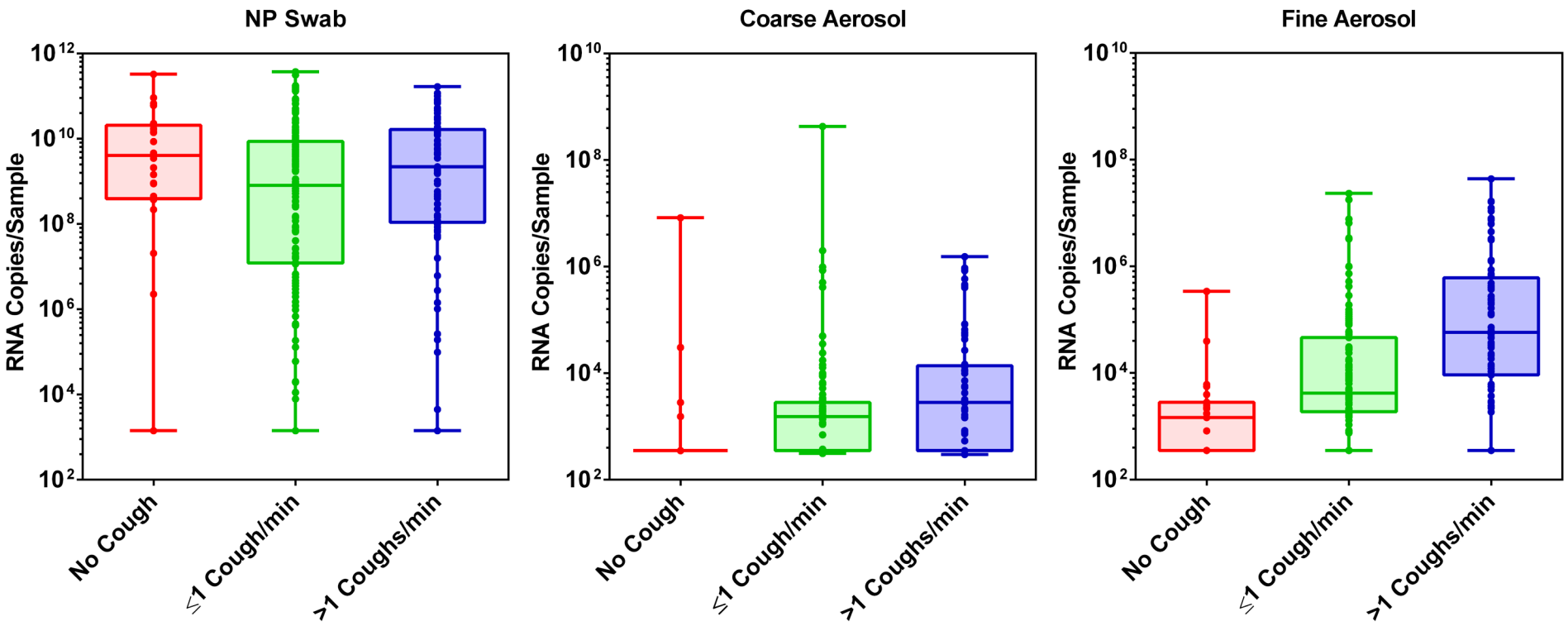


NP = nasopharyngeal swab, Coarse & Fine = aerosol particles, RNA by qRT-PCR, FFU = Fluorescent focus assay in MDCK cells

- Correlation Focus counts: RNA Copies
  - NP swabs r=0.60, p<0.0001
  - Fine aerosol r=0.34, p<0.0001

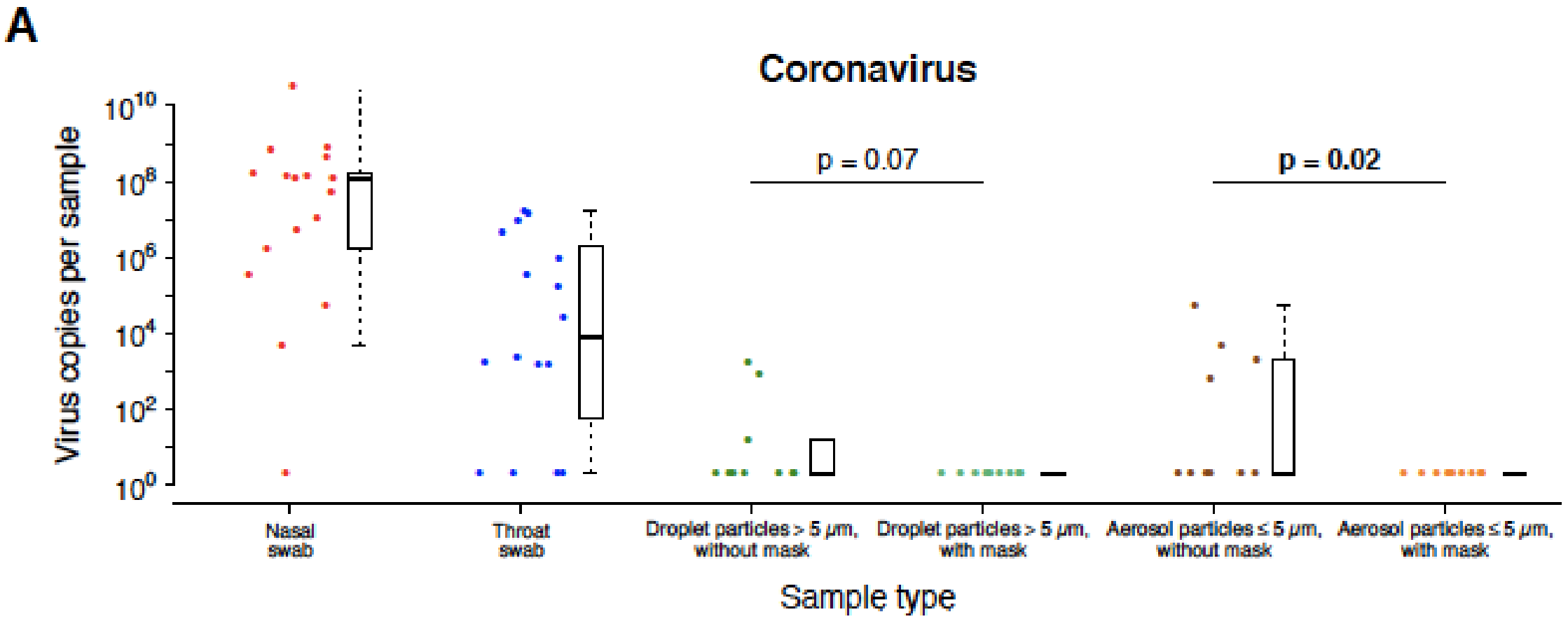
J. Yan *et al.*, *Proc. Natl. Acad. Sci. U.S.A.* **115**, 1081–1086 (2018)

Cough & Influenza Aerosol Generation



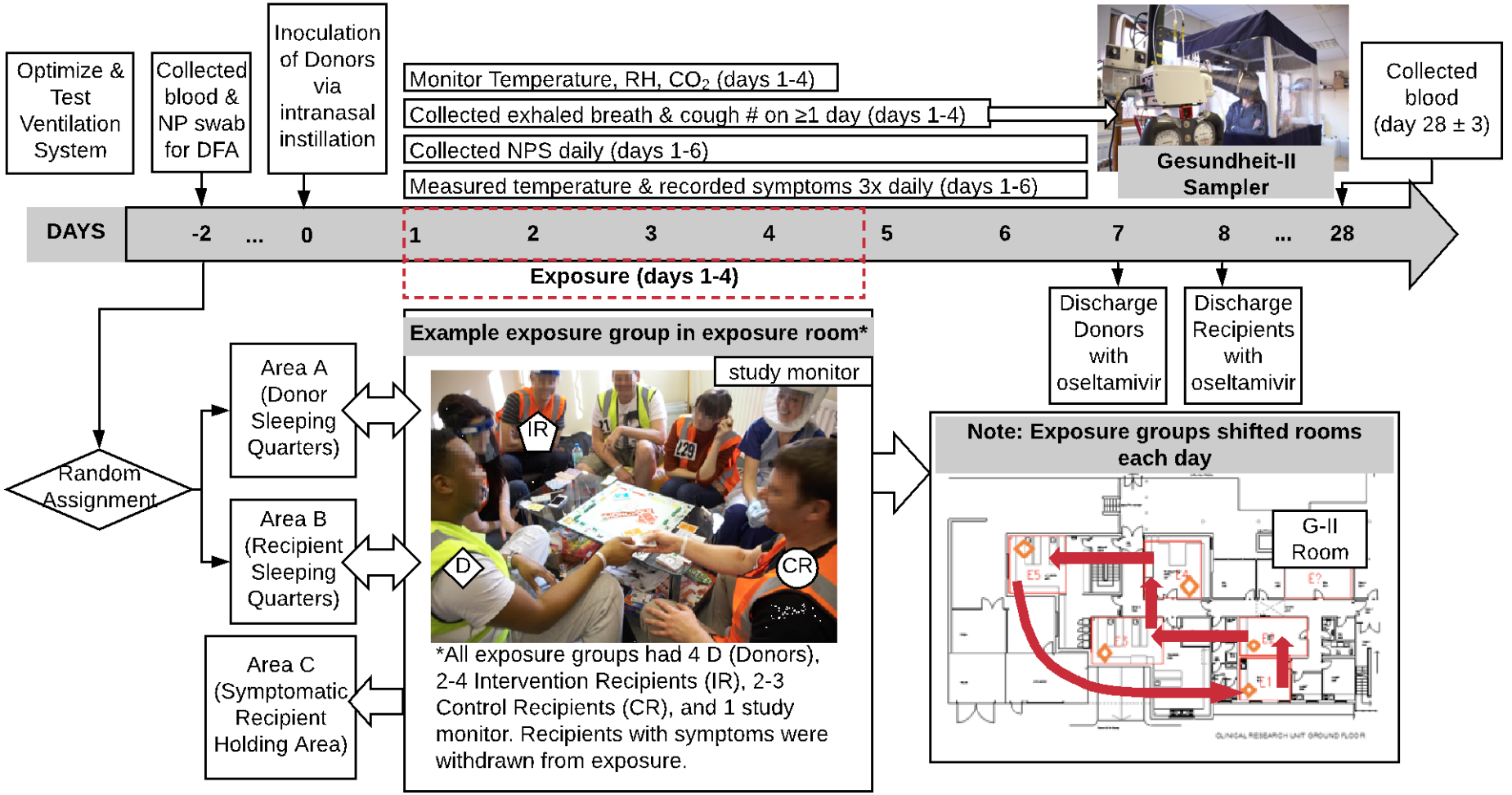
J. Yan *et al.*, *Proc. Natl. Acad. Sci. U.S.A.* **115**, 1081–1086 (2018)

Masks as Source Control Seasonal Coronaviruses



N. H. L. Leung *et al.*, *Nature Medicine*, 1–5 (2020).

Randomized Controlled Transmission Study?



J. S. Nguyen-Van-Tam et al., PLOS Pathogens. 16, e1008704 (2020).

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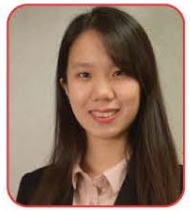
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