Appendix S2 – Rationale for infectiousness parameterization to simulate a SARS-CoV-2 superspreading event

Farthing TS, Lanzas C. 2021. Assessing the efficacy of interventions to control indoor SARS-Cov-2 transmission: An agent-based modeling approach. *Epidemics*. doi: 10.1016/j.epidem.2021.100524.

As noted in the main text, for benchmarking purposes, we simulated the Skagit County, Washington, USA March 2020 SARS-CoV-2 superspreading event as case scenario. Miller et al. (2020) estimated that the infectious individual in the Skagit County case study emitted 970 ± 390 SARS-CoV-2 quanta/hr. A quantum is the number of aerosolized infectious particles required to infect 1- 1/e % (i.e., ≈ 63%) of a susceptible population, assuming that all individuals were exposed to the same number of particles (Wells 1955). Here we describe how we estimated the virion risk associated with 1 quanta min^{-1} to be used in our SARS-CoV-2 transmission efforts. To do this, we ran a modified version of our agent-based model, wherein the droplet fallout procedure (see Appendix S1) was carried out before the infection procedure, and droplets were homogenously dispersed throughout the entirety of the simulated world immediately after expectoration. We parameterized our modified model to reflect the choral super-spreading event described by Hamner et al. 2020 (Table S2-1). We varied 22 virion infection risk levels across 220,000 simulations (i.e., 10,000 simulations per level). All simulations lasted only a single time step, after which we recorded the percentage of susceptible individuals infected. After evaluation, all simulations were aggregated into a single data set, and we carried out a linear regression to relate the percentage of susceptible people infected to the virion risk:

$$\%\text{ infected} = \beta_0 + \beta_1 virionRisk.$$

We determined that

$$\%\text{ infected} = 0.0027 + 10.06 virionRisk.$$

Given this formula, we calculated that a virion risk value of 0.0624 is required to infect 63% of susceptible in our parameterized quantum-simulation model. We adopted this value as the virion risk in all primary simulations.

The number of droplets produced by the infectious individual in our simulations each minute was independent of coughing status, and like droplet travel distance estimation, was drawn from a log-normal distribution using the procedure described by Railsback & Grimm (2011). The known mean and standard deviation values for this distribution were $9.7e^5$ and $3.9e^5$ droplets, respectively, to recreate the 970 ± 390 quanta/hr estimated by Miller et al. (2020).

References

1. Hamner L, Dubbel P, Capron I, Ross A, Jordan A, Lee J, et al. High SARS-CoV-2 attack rate following exposure at a choir practice – Skagit County, Washington, March 2020. Morb Mortal Wkly Rep. 2020; 69:606-610. doi: 10.15585/mmwr.mm6919e6.

2. Miller SL, Nazaroff WW, Jimenez JL, Boerstra A, Buonanno G, Dancer SJ, et al. Transmission of SARS-CoV-2 by inhalation of respiratory aerosol in the Skagit Valley Chorale superspreading event. Indoor Air. 2020;00:1-10. doi: 10.1111/ina.12751.

3. Railsback SF, Grimm V. Agent-Based and Individual-Based Modeling: a Practical Introduction, 1st edition. Princeton University Press: Princeton, New Jersey, U.S.A. 2011. pp. 195-208.

4. Wells WF. Airborne contagion and air hygiene: an ecological study of droplet infections. JAMA. 1955;159(1):90. doi: 10.1001/jama.1955.02960180092033.

Tables

Table S2-1. Parameters for SARS-CoV-2 quantum simulation.

Parameter	**Value(s)**	**Reference(s)**
Area (m^2)	180	Hamner *et al.* 2020
Cough frequency (coughs/min)	0.19	Lee *et al.* 2012
Droplet count (droplets/expectoration)	60,000	Stadnytskyi *et al.* 2020
Expectoration height (m)	1.7	Fryar *et al.* 2018
Inhalation rate (m^3 air/min)	0.023	Adams 1993
Maximum people in a single 1-m^2 patch (people)	2	Hamner *et al.* 2020
virion count (virions/mL fluid)	$2.35e^9$	Wölfel *et al.* 2020
virion decay rate (%/min)	1.05	van Doremalen *et al.* 2020
virion infection risk (%/inhaled virion)	$1.0e^{-5}$, $3.0e^{-5}$, $5.0e^{-5}$, $8.0e^{-5}$, $1.0e^{-4}$, $3.0e^{-4}$, $5.0e^{-4}$, $8.0e^{-4}$, 0.001, 0.003, 0.005, 0.008, 0.01, 0.02, 0.03, 0.04, 0.05, 0.06, 0.07, 0.08, 0.09, 0.1	–