SAFE OCCUPANCY OF GRADUATE STUDENT OFFICE SPACES

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QUANTIFICATION OF EXPOSURE

- There is essentially universal agreement that a finite amount of total viral exposure is needed for a person to become ill
  - This amount is not known (although estimates exist)
- *Proposed* quantification for our purposes: "Contact Trace"
  - Contact Trace is number of "spittle" particles inhaled if a person is 2 m from a speaking source for 15 minutes

"CONTACT TRACE"

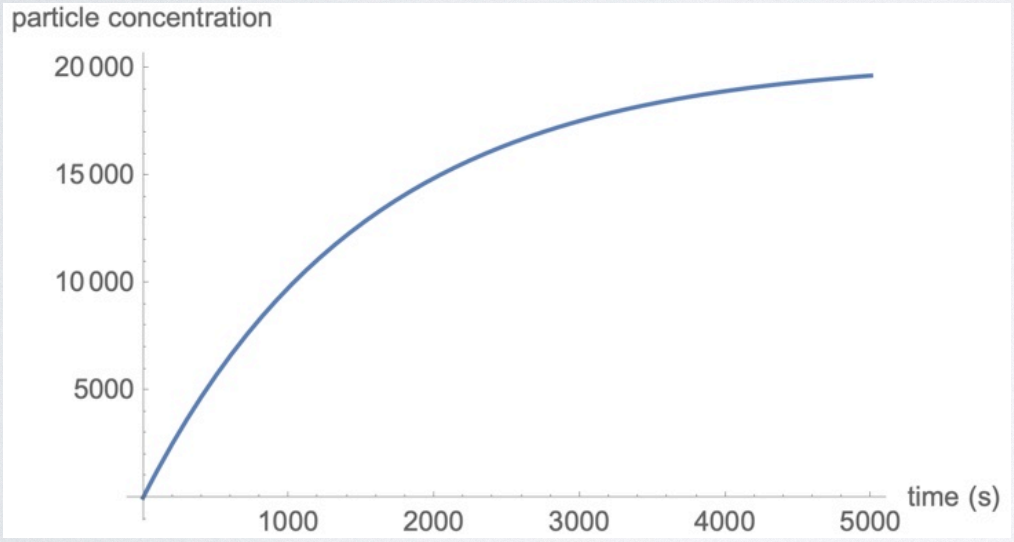
- While the numbers vary widely, normal speaking produces a continuous stream of particles less than about 5 μm which are readily aerosolized and others up to about 25 μm which evaporate fast enough to become aerosols.
- A 2 m radius sphere has a surface area of 50 m^2. If a person takes 20 breaths per minute, and we "estimate" a person could capture about 0.5 m^2 of the flux. Then the inhaler would be getting 1/300 of the particles emitted by the speaker.
- Thus a "Contact Trace" is: particle emission rate*15*60/300 = "s" (particles/s)*3 (equivalent) s.
  - — that is you get 3 secs of *aerosol* emission by the other person (not the big particles that fall to the ground).

PARTICLE BALANCE ON ROOM

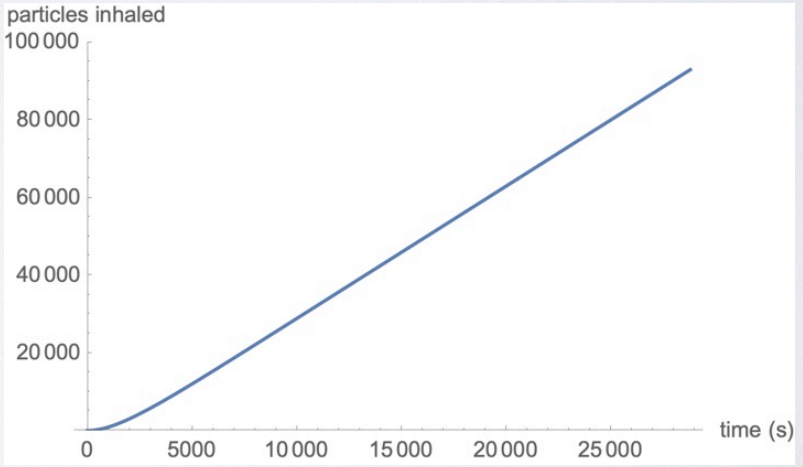
$$\frac{\partial (V\,\mathrm{cp}(t))}{\partial t} = -k\,V\,\mathrm{cp}(t) - q\,\mathrm{cp}(t) + S$$

$$\mathrm{cp}(t) = \frac{S\left(1 - e^{-t\left(k+\frac{q}{V}\right)}\right)}{k\,V + q}$$

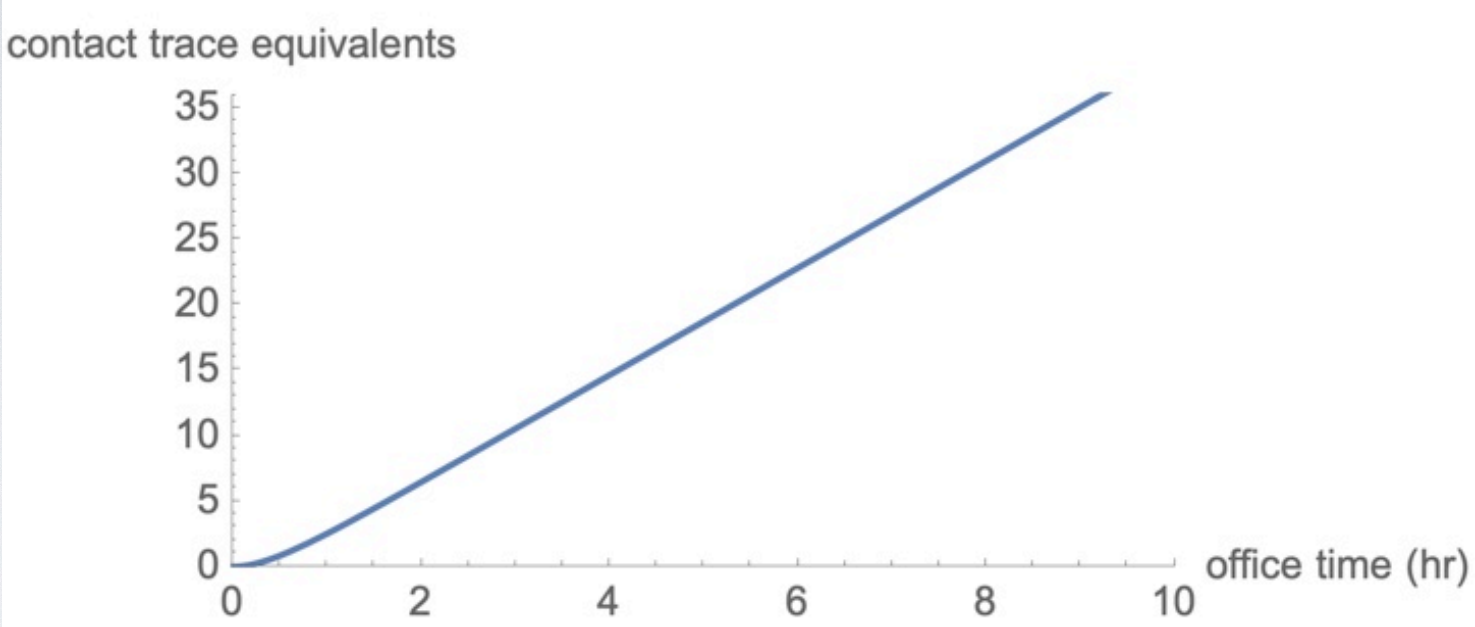
75 m^3 room, 2 room turnovers/hour, 1 source



$$\mathrm{totalintake} = \frac{\mathrm{qbreath}\,S\left(V\left(e^{-\mathrm{tx}\left(k+\frac{q}{V}\right)} + k\,\mathrm{tx} - 1\right) + q\,\mathrm{tx}\right)}{(k\,V+q)^2}$$



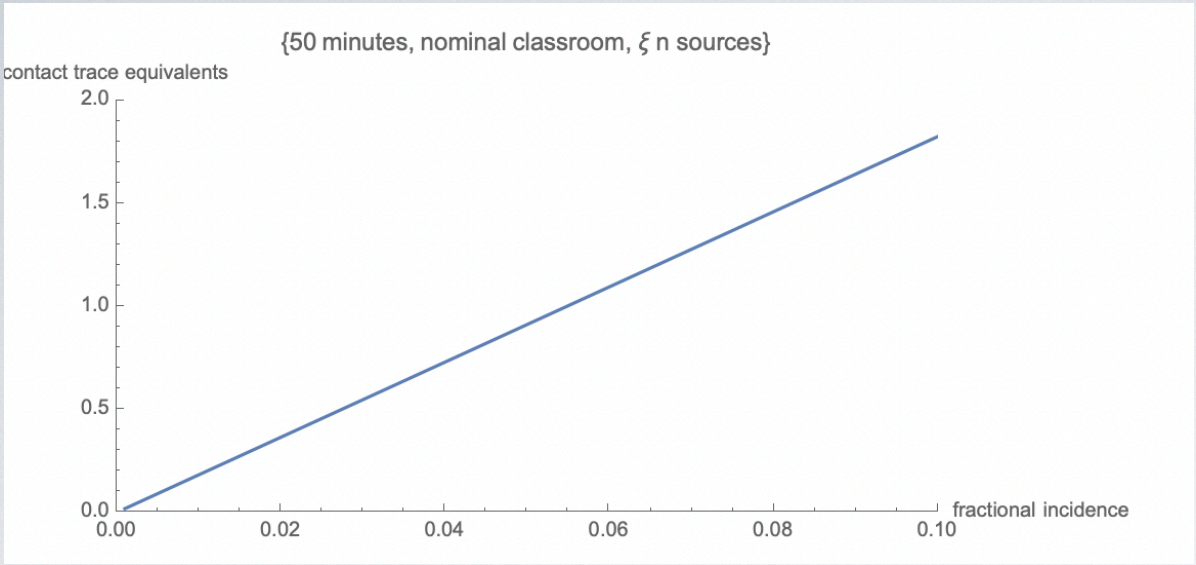
OFFICE TOTAL EXPOSURE

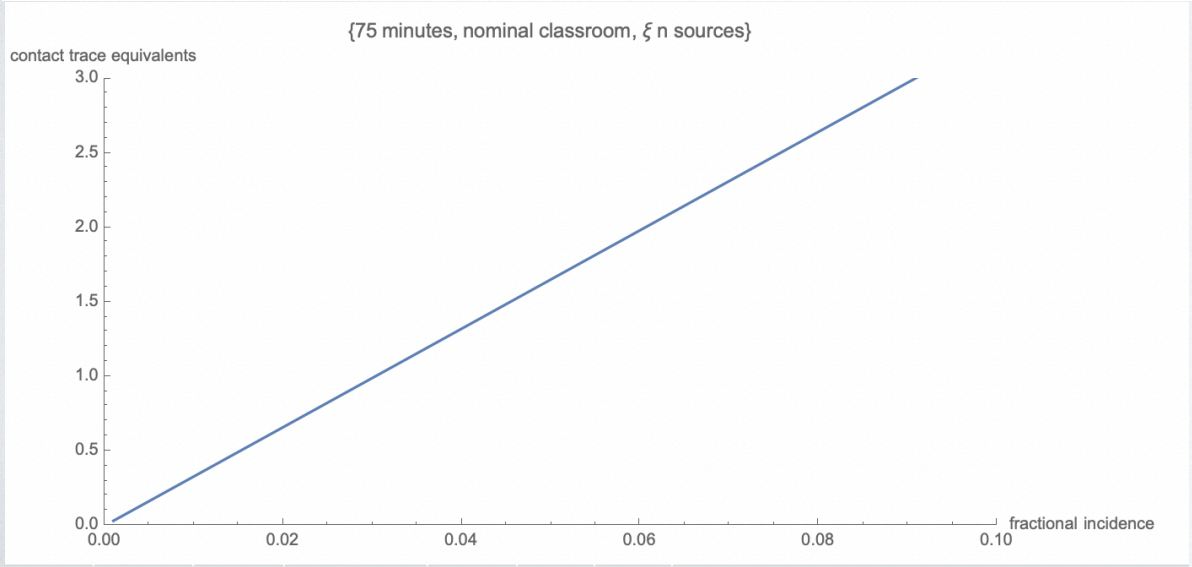


- A cloth mask will remove 90-95% of total emitted load, but a much smaller fraction of the aerosol particles.
- Not speaking drops the total load by an order of magnitude, but again, a much smaller fraction of the emitted particles.

DOSE IN TERMS OF "FRACTIONAL INCIDENCE"

- It is possible to include probability of an infectious source in a classroom or office.
  - Source is now: ξ n, where ξ is the fraction of infected people and n is number of people in a volume.
- We then normalize this for 1 person by picking the room volume as n*Vs, where Vs is the volume for 1 person, 7.86 m^3 for a classroom (6 ft diameter and 10 foot ceiling) or an 7.1 m^3 for an office (6 ft diameter and 9 foot ceiling)
- This allows a plot of "contact traces" versus fractional incidence, ξ, for a chosen amount of time,

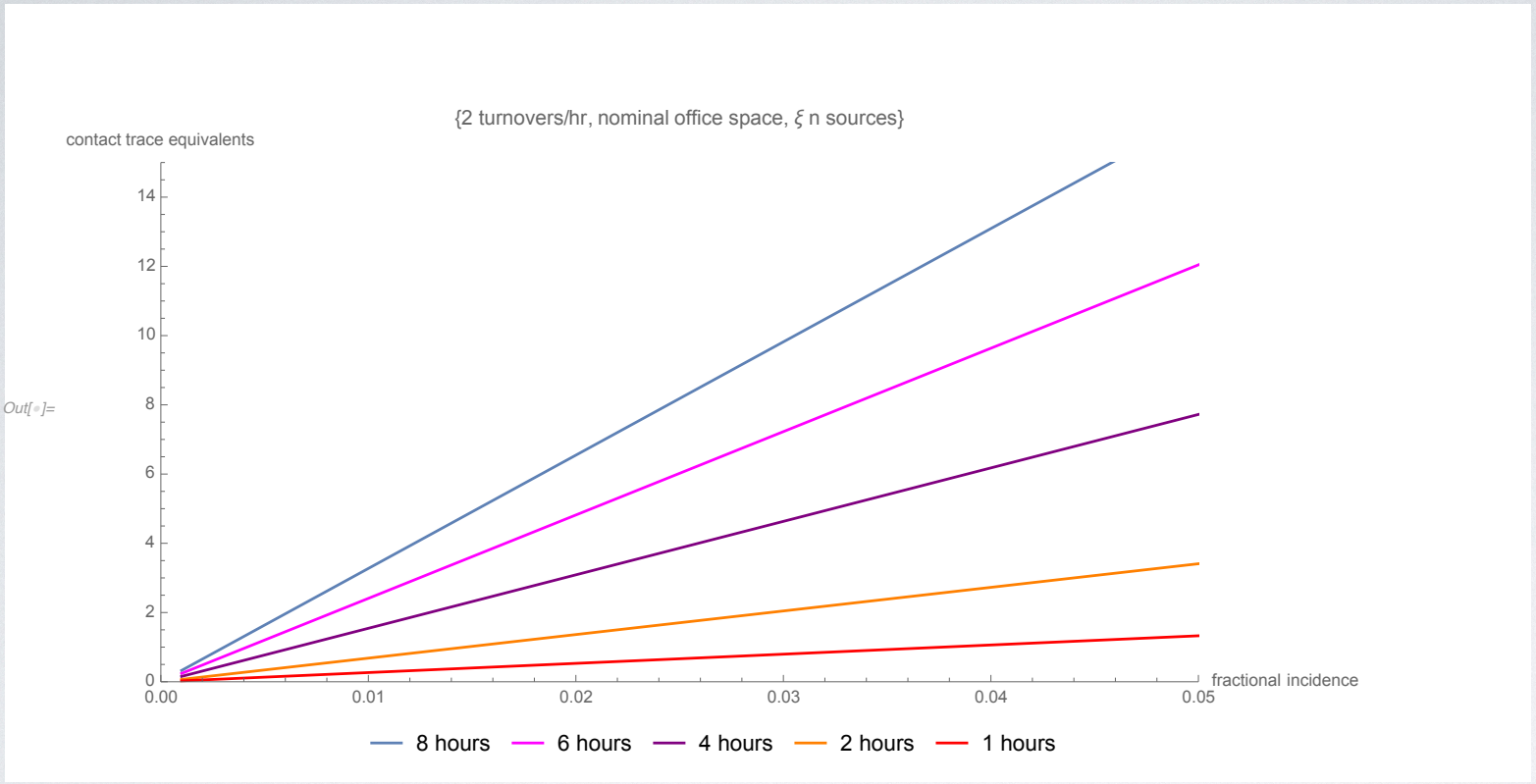




Classrooms

- Thus for a classroom configured with the standard spacing, 6 ft apart, if the incidence of infection is below about 5.5%, no one would be getting a full contact trace in a 50 minute class
- For a 75 minute class, the incidence would need to be below ~3.5%.

Grad office with different times of exposure



- For a grad student office, the situation is not as good. For 1 hour or maybe 2 hours, these are probably OK.
- However for an 8-hour day. To stay below 1 contact trace, the incidence would have to below 0.4%.

EFFECT OF VENTILATION RATE