Covid Reduce

Web Application for quanta calculation

This web application provide corona-viral load for an individual over whole day that are divided into multiple events. This calculation is based the work proposed by Morawska and Cao (2020), Morawska (2006), and Li et al. (2005).

The calculation of viral is based on estimation of a relative metric called "*quanta*" that are based on multiple parameters, like volume of the room, air exchange etc. Quanta can be translated to the probability estimates of viral infection and further used for estimating R_0, a metric which is used to depicting whether a disease is pandemic or not.

All calculation is based only for the airborne transmission of the virus. This calculation is applied to distances greater than 2 meters. Quanta calculation doesn't consider viral load less 2 meters. The dynamics and spreading medium will be very different for less than 2 meters and not the focus of this study. There is other form of viral transmission that can dominate less than 2 meters like indirect fomite, direct sneeze/cough contact etc.

Quanta based calculation also assumes a Box Model approach i.e., the virus droplets (size approximately 2-10 microns) exhaled in the environment will instantaneously and completely mixes in the air creating uniform viral concentration across the room of given volume. It is important to note that instantaneous is relative compared to total time of the event. For a huge room this

assumption may not be valid and requires Computational Fluid dynamic (CFD) modeling techniques to accurately predict the viral mixing.

This model is a simplification of the CFD based techniques to reduce the computational and mathematical complexity of viral droplet dynamics in air and not knowing the exact location of spreader.

Based on this assumption quanta calculation are model using approach described in *Buonanno et al. (2020a) and Buonanno et al. (2020b)*. Please follow detail in *{REF}* and the references therein. A quanta D_q can be estimated using following equation,

$$D_q = \frac{I_r \cdot (1 - e_h) \cdot E \cdot (1 - f_i \cdot e_m) \cdot i \cdot T}{Q \cdot V} \left[1 - \left(\frac{1 - e^{-Q \cdot T}}{Q \cdot T} \right) \right]$$

Where,

$$\boldsymbol{Q = A + k + \lambda}$$

D_q	Quanta concentration over the total exposure time	
E	Quanta Emission Rate quanta	hr^{-1}
I_r	Inhalation Rate	$m^3\ hr^{-1}$
f_i	Fraction of Infected People	
e_m	Efficiency of Mask (Infected)	
e_h	Efficiency of Mask (Healthy)	
i	Number of infected people	
T	Total time of the event	hr
V	Volume of Room	m^3

Q	Total Infectious Viral Removal Rate	
A	Air Exchange Rate	hr^{-1}
k	Particle Deposition Rate	hr^{-1}
λ	Viral Inactivation Rate	hr^{-1}

Above equation can be used to estimate quanta for an expose time, *T*, given all parameters of room like ventilation and volume, assuming number of infected people, viral shredding rate, mask efficiency etc.

There equation is further used to estimate a *cumulative-quanta* score for a whole day given the parameters for each event type.

Figure 1 provides some examples scenarios before and after changes are made to reduce the quanta/infection risk: Figure 2 shows the six dimensions that determine the risk. Typically one can find a combination of conditions that provide low infection risk (less than less than 0.02% even if a spreader is present).

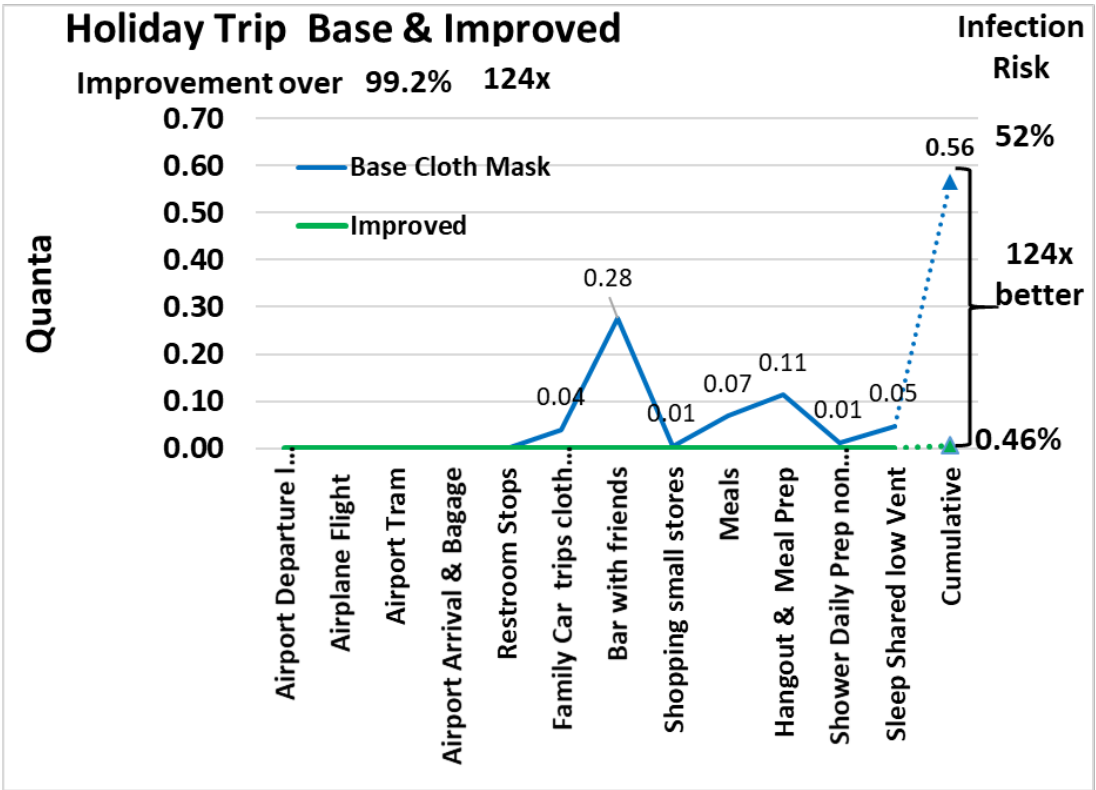

Figure 1 Infection risk quanta prediction for events holiday trip. The blue line shows the initial quanta in risk of infection if a spreader is present. The green line shows the improved day wearing N95 masks when masking, having bar trip ouside and ventilation changes to reduce the risk.

Six dimensions of Covid Reduction & Equation

1. **Masking – highly reducible at low cost–** improve the quality and correct use of masks
2. **Duration of event – generally fixed. R**educe time of events that high risk (e.g., shorten time in crowded hallway)
3. **Room volume – typically fixed.** – but move to larger spaces when can (e.g., lunches in big cafeteria or outside)
4. **Ventilation – highly reducible risk at modest cost** – open the windows, install exhaust fans or HEPA air cleansers
5. **Reduce spreader exhaust quanta - range of costs** use temperature checks to keep away spreaders or ware high quality masks
6. **Social distance/exposer exhale plum - reducible with masking.** In interior spaces increase quality masking, try to keep 6 feet open in direction of head, if not possible direct exhaust plum in non overlapping directions

Note we are not modeling fomite (surface) transmission assuming people use good hand hygiene to minimize that risk

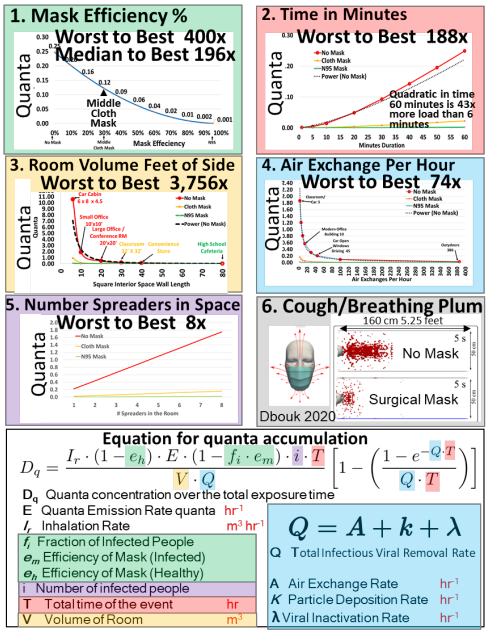

Figure 2Figure 2. This shows a sensitivity analysis of the six dimensions that predict quanta/infection risk. The color overlays in the lower left equation match highlight which graph shows that factor. The individual terms are generally nonlinear with large effect sizes. The spread sheet tools do the calculations for you.

Covid Reduce web app can allow user to provide platform to estimate quanta for each daily event and save a excel sheet for references and make strategy to reduce daily viral load. Covid reduce will provide a report in word document and power-point slides based on the users inputted events and corresponding quanta. It allows user to compare graph for different event with or without mask or mask with different efficiency.

This app can also we used by organization to make strategic planning for gathering of people in a classroom or any other events.