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LETTER TO THE EDITOR

PEDIATRIC PULMONOLOGY WILEY

# The cumulative risk of acquiring COVID-19 in outpatient pediatric practice

To the Editor,

Pediatric pulmonologists, and indeed general pediatricians and other subspecialists, are exposed to the causative virus of COVID-19 (severe acute respiratory syndrome coronavirus 2 [SARS-CoV2]) in their daily outpatient practices from both symptomatic and asymptomatic patients. This risk naturally increases with multiple exposures over time. To describe how risk could be affected by disease prevalence, transmissibility, patient volume, and mitigating factors such as personal protective equipment (PPE), we have developed a simple equation for the probability of a practitioner remaining COVID-free over a specified time interval. We were unable to find similar calculations in the literature, although analogous concepts have been explored in considering communicable disease risk to *patients* from multiple exposures to practitioners and other patients in healthcare settings.[1]

In our analysis, we assume that $R$, the risk of each patient encounter = average prevalence in population ($P$) × transmission rate/encounter (T) × PPE mitigation factor ($M$).

If $1 - R$ = probability of remaining COVID-free after one encounter, and total encounters ($E$) over one year = encounters/day × patient days/week × weeks/year, then to calculate cumulative COVID-free probability (CFPc):

$$\text{CFPc} = (1 - R)^E$$

$$\text{CFPc} = (1 - \text{PTM})^E.$$

(This is a binary outcome, much like a coin toss—heads/tails is analogous to COVID/COVID-free. The number of encounters is an exponent for much the same reason that the odds of tossing a “heads” on three successive tosses of a coin are $(1/2)^3 = 1/8$. Since the practitioner must remain COVID-free on *each* successive encounter, not just one, and since the COVID-free probability is slightly less than one after each encounter, the probability goes slightly down with each successive encounter).

For example, if one makes the following assumptions for the clinical practice of one practitioner over a year:

Daily population prevalence ($P$) of 2% over the exposure period = 0.02.[2]

Transmission rate ($T$) of 1 in every 100 close encounters = 0.01.[3]

PPE mitigation factor ($M$) = 1.0 for no mask, 0.33 for a surgical mask, and 0.04 for an N95 mask.[4]

Encounters/year ($E$) = 12 patients seen/day × 3 patient days/week × 46 patient weeks/year = 1,656.

Then, the probability of remaining COVID-free for a year if the practitioner wears a surgical mask can be calculated as

$$\text{CFPc} = (1\text{-}0.02 \times 0.01 \times 0.33)^{1656} = 0.99993^{1656} = 0.89, \text{or}89\%.$$

Similarly, the probability is 72% with no mask, and 98% with an N95 mask. The equation can be used to construct a Kaplan–Meier like plot for remaining COVID-free (Figure 1).

Studies of transmission of SARS-CoV2 suggest a spectrum between droplet and aerosol spread, even in asymptomatic patients and the absence of aerosol generating procedures.[5] Thus the type of masks worn by medical practitioners may mitigate risk to different degrees. While the relative protection offered by N95 masks over surgical masks is not precisely established, we used an estimate provided by a recent meta-analysis.[4]

Our equation is modifiable, according to local prevalence, transmission efficiency, number of patients seen per year by the provider, and quality of mask mitigation. There are of course other factors that mitigate risk. Eyewear may further mitigate this risk,[4] as could the efficiency of exam room ventilation systems. If these mitigators are independent of one another, and if their mitigating effect could be estimated, their product could be incorporated into the term “M.” Other factors which could increase the risk include the presence of one or more adult caregivers, which could act as an increase in “E.” Other factors not so easy to quantify are the presence of underlying chronic pulmonary diseases that could lead to increased cough or secretions, older patient age, and the presence of airway hardware such as a tracheostomy. However, the model does suggest that if certain aspects, e.g., room ventilation, are controlled, the effects of other aspects of the visit, such as masks, can be quantitated. Each patient encounter thus presents an opportunity for minimizing the risk depending on the variables that can be controlled.

The figure shows that while the risk of acquiring COVID-19 in a year of practice is low, it is not negligible, and can be affected to varying degrees by protective measures. These considerations may be helpful in deciding local risk to the practitioner according to practice volume and in choosing the level of PPE or other mitigations that would result in minimizing that risk.

## CONFLICT OF INTERESTS

The authors declare that there are no conflict of interests.

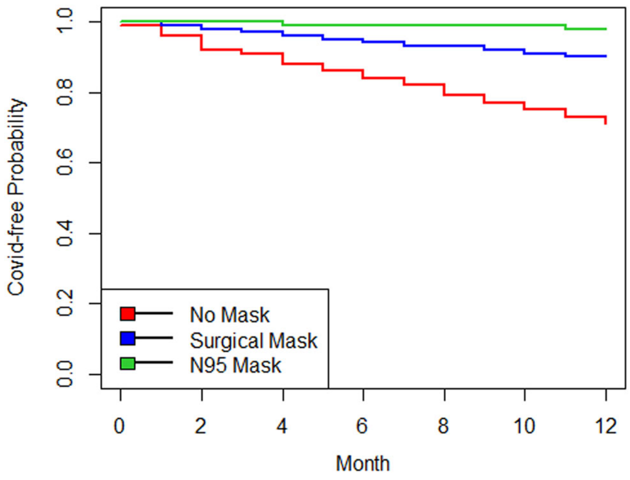


**FIGURE 1** Cumulative probability of a pediatric practitioner wearing different levels of facemask protection remaining COVID-free during a year of out-patient practice (given the assumptions discussed in the text). Red: no mask; Blue: surgical mask; Green: N95 mask [Color figure can be viewed at wileyonlinelibrary.com]

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