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## Considerations for Assessing Risk of Provider Exposure to SARS-CoV-2 after a Negative Test

### To the Editor:

Coronavirus disease 2019 (COVID-19) is caused by infection with the severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2). The transmission of coronaviruses occurs *via* direct contact, droplets, and aerosols. Healthcare professionals involved in airway management of patients infected with SARS-CoV-2 are at high risk of exposure and subsequent infection, as has been observed in previous coronavirus epidemics.<sup>1</sup> This risk is most pronounced in aerosol-generating procedures such as intubation. On March 22, 2020, the American Society of Anesthesiologists (Schaumburg, Illinois), in partnership with other professional organizations, offered guidance for the use of personal protective equipment that have been interpreted by some providers as recommending the use of airborne precautions for all aerosol-generating procedures during the pandemic.<sup>2</sup>

Healthcare systems operating under pandemic conditions may need to balance the protection of staff with the allocation of scarce resources, including personal protective equipment. One strategy to address this problem relies on preprocedural testing of asymptomatic individuals. Recent publication of data suggesting imperfect clinical sensitivity of reverse transcription polymerase chain reaction assays for SARS-CoV-2<sup>3</sup> could lead healthcare

providers to intuitively question the wisdom of a strategy that relies on a negative SARS-CoV-2 test, particularly

when planning high-risk procedures such as endotracheal intubation. Knowledge of test characteristics, however, is insufficient to guide decision making: the prevalence of the disease in the population for which the test is performed has a critical bearing on the information provided by the test. Prevalence estimates are complicated by the fact that they will differ (sometimes substantially) between different locations, may be unavailable or poorly measured, and will be inherently dynamic during a pandemic. These uncertainties may substantially affect the safety of both patients and providers and may impact the utilization of scarce resources such as personal protective equipment.

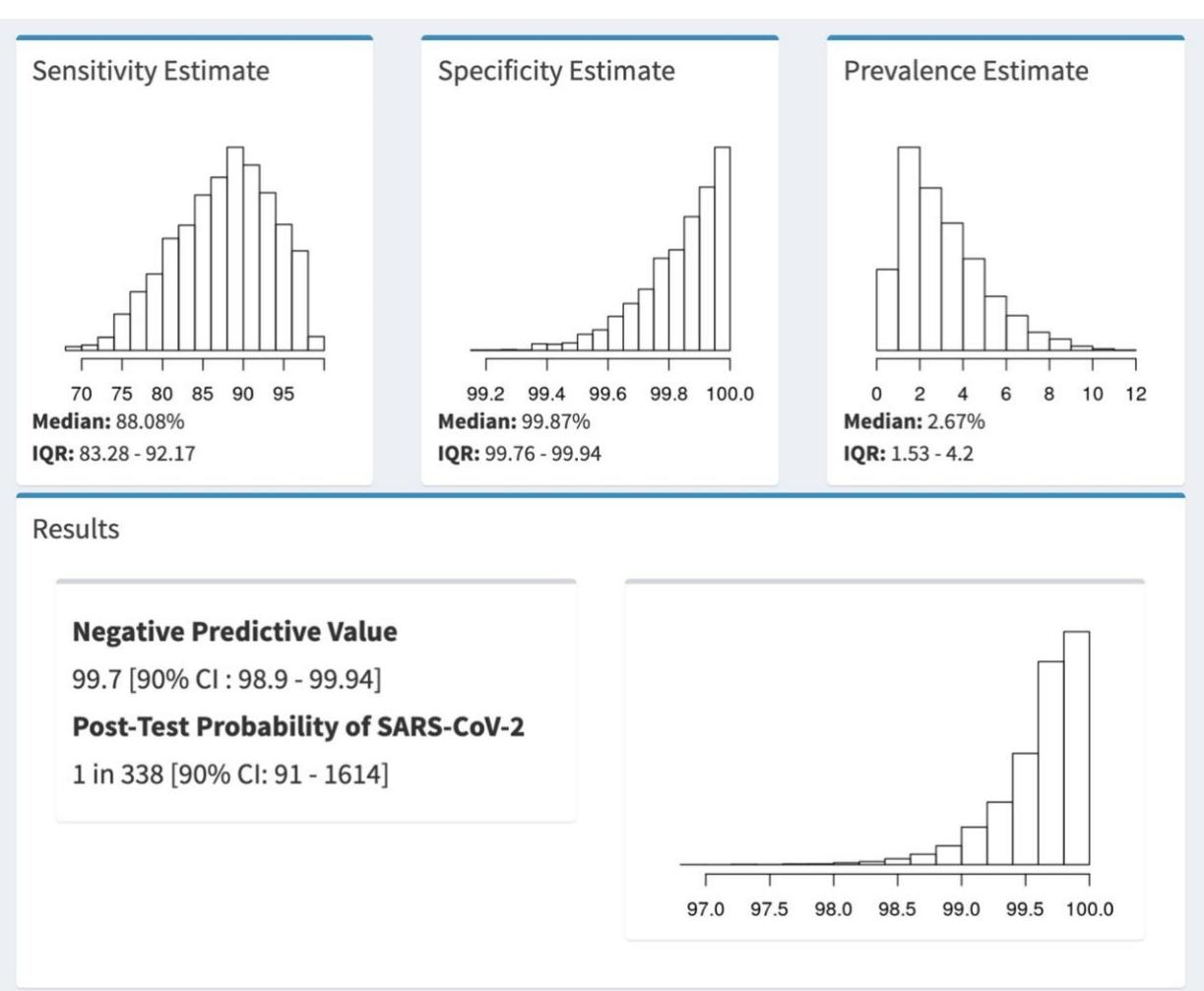
To help providers and clinical leaders grapple with this dynamic uncertainty, we have developed an online tool (<https://covid-airway-npv.info>) that enables the user to examine the impact of different assumptions regarding SARS-CoV-2 reverse transcription polymerase chain reaction test characteristics and disease prevalence on the potential risk of provider exposure during airway management. Uncertainty is modeled by asking the user to provide the most likely, minimum, and maximum value of the parameter (here, SARS-CoV-2 testing characteristics and COVID-19 community prevalence), using a Project Evaluation and Review Techniques distribution.<sup>4</sup> The Project Evaluation and Review Techniques distribution was initially developed by the U.S. Navy in an effort to add mathematical rigor to the process of complex project planning, and requires users to provide input uncertainty to enable modeling of output uncertainty.<sup>5</sup>

To inform an example calculation, we use publicly published data for analytic specificity of the Quest Diagnostics reverse transcription polymerase chain reaction assay (likely 100%, minimum 95%, maximum 100%) and an informed but pessimistic assumption regarding the clinical sensitivity of the reverse transcription polymerase chain reaction assay (likely 90%, minimum 65%, maximum 99%). Estimation of population prevalence is challenging: the minimum in this scenario is based on a recent measurement of the prevalence of reverse transcription polymerase chain reaction positivity among asymptomatic individuals in Iceland (0.6%), while our maximum is based on a recently published estimate among asymptomatic parturients at a major academic center (13.8%).<sup>6,7</sup> As is the case with nearly all measurements of disease prevalence, both of these estimates were measured in unique populations at specific points in time. We chose a “most likely” prevalence estimate of 1.0% based on preliminary, unpublished data emerging from various screening programs within our own health system. A screenshot from

the calculator’s analysis under these assumptions is depicted in figure 1. A 90% credible interval for negative predictive value is bounded by 0.06% and 1.12%, giving posttest probabilities of disease ranging from 1 in 89 to 1 in 1,636, and centered at 1 in 338. It is worth noting that a provider in Iceland and another in New York City might have very

different assumptions regarding the most likely, minimum, and maximum estimates in their hospitals.

We believe that in the setting of a pandemic, airway providers and clinical leaders should engage in this type of quantitative risk assessment—even when that assessment is bounded by significant uncertainty—because it yields four important insights. First, when SARS-CoV-2 is demonstrably uncommon in the population presenting for care, the negative predictive value of a SARS-CoV-2 test should provide reassurance to the individual clinician



**Fig. 1.** Screenshot from <https://covid-airway-npv.intelcalculator.com>. Negative predictive values and posttest probability of SARS-CoV-2 infection under specific assumptions of sensitivity, specificity, and prevalence. IQR, interquartile range.

regarding their case-by-case risk of exposure from an asymptomatic and test-negative patient. Second, in a setting with high surgical volumes, the same calculation could paradoxically provide an opposing perspective: a provider exposure risk that potentially ranges from 1 in 89 to 1 in 1,636 indicates that a busy hospital utilizing droplet precautions for intubation of asymptomatic, test-negative patients could be tolerating the exposure of staff members to aerosolized SARS-CoV-2 on a regular basis. The third insight involves periods or regions in which active disease prevalence is known to be high: full airborne precautions should be considered even for test-negative patients, given the risk of exposure during airway management. Fourth, and perhaps most challenging to grapple with: the uncertainty in our estimates of the components that define negative predictive value generates a wide interval of possible risk that must be acknowledged and thoughtfully considered by clinicians and healthcare leaders.

In an emergency, decisions will be made in the absence of definitive data, and these decisions may be harshly judged in the future through the lens of hindsight. A rational, quantitative approach to decision making has the potential to provide a shared understanding of actions taken in the face of uncertainty. In the case of airway management, we believe that decision makers could specify a lower threshold

of negative predictive value that would justify the use of universal airborne precautions, irrespective of preoperative test results: given the relatively fixed characteristics of the reverse transcription polymerase chain reaction test, any such change would be driven by estimates of population prevalence. As a specialty, we should engage in a continuous, transparent process of adapting these policies in collaboration with other leaders and stakeholders in the context of new information.

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## Competing Interests

The authors declare no competing interests.

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# An Online Educational Platform in the COVID-19 Pandemic

## To the Editor:

We bring to your attention the unique features of our specialized departmental coronavirus disease 2019 (COVID-19) website, purpose-built to disseminate training resources; particularly highlighting the clarity of the structure and infographics, as well as the efficiency and

acuity required to ensure accuracy. The benefit of having an online educational platform during the COVID-19 pandemic has been previously reported.<sup>1</sup> At the start of the pandemic in the United Kingdom, our anesthesia and intensive care (usually separate) departments merged. Our preexisting anesthesia website (<https://rfanaesthesia.org>) was rapidly adapted to include a COVID-19 page with contributions from experts in both specialties.

Clinical guidelines are displayed in sections of anesthesia, intensive care, and obstetrics, including information for non-medical staff. Infographics are used to facilitate quick review, either by carousel (*e.g.*, adult advanced life support, COVID-19 intubation guidance), or one-click access icons (*e.g.*, COVID-19 ventilation strategy). The training section includes several video demonstrations and specific cross-training resources for non-anesthesiologists and nonintensivists. A detailed communications section highlights the most efficient contact pathways between teams

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