CORRESPONDENCE

Re-visiting preoperative SARS-CoV-2 testing using a Bayesian approach

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To the Editor,

Dr. Lothar recently presented a thoughtful editorial discussing preoperative severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) nucleic acid amplification tests (NAAT).¹ Nevertheless, to further help clinicians properly interpret these tests, we would like to highlight important nuances made evident when considering a Bayesian statistical approach.

Sensitivity and specificity are test characteristics reflecting the test's ability to correctly identify those with or without disease. These values do not offer specific information concerning a patient's disease risk. Positive predictive value is the probability of correctly identifying patients with positive test results who truly have the disease, with the negative predictive value correspondingly being the probability of correctly identifying those with negative tests who truly are disease-free. Although useful, these values clearly have downsides—i.e., they vary

depending on disease prevalence and do not inform clinicians of the significance (in terms of probability of having the disease) of a positive or negative test result for a given patient.²

As likelihood ratios account for disease prevalence, they add clarity by providing a post-test probability of a patient's disease status that is easy to interpret. Using the sensitivity and specificity provided by Dr. Lothar's article of 70% and 95%, respectively,¹ we calculated a positive likelihood ratio (LR+) of 14, and a negative likelihood ratio (LR−) of 0.32 (see eFigure in the Electronic Supplementary Material [ESM]).³ A LR+ informs the clinician how much to increase the probability of having SARS-CoV-2 given a positive SARS-CoV-2 NAAT. Similarly, a LR− tells us how much to decrease the probability of having SARS-CoV-2 given a negative SARS-CoV-2 NAAT.

As an example, by 3 July 2020, Alberta had a SARS-CoV-2 rate of 1,890 positive cases for 94,443 tests per 1,000,000 population, representing a positivity of 2.0% (ESM eTable)—i.e., a low prevalence setting.⁴ This crude prevalence can be converted to a pre-test odds of 0.02. For a positive test, post-test odds are obtained by multiplying the LR+ by the pre-test odds. A similar calculation is performed for a negative test using the LR−. The post-test odds can be converted back to post-test probability. In this low SARS-CoV-2 risk example, a positive test will increase the post-test probability to 22.2%, whereas a negative test will decrease the post-test probability to 0.6%.⁵ (Table) Although false-positive tests are possible (related to laboratory factors such as carry-over contamination), most clinicians would consider a positive result during the present pandemic as a true positive. Clinicians' acceptance of risk levels influences the interpretation of a negative test; many would agree that a

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Table Post-test probability of SARS-CoV-2 by disease prevalence and number of tests

Risk group	Pretest probability (prevalence)	Post-test probability after first test	Post-test probability after second test
Low	2%	Positive: 22.2%	Positive: 80.0%
		Negative: 0.6%	Negative: 0.2%
Intermediate	5%	Positive: 42.4%	Positive: 91.2%
		Negative: 1.6%	Negative: 0.5%
High	10%	Positive: 60.9%	Positive: 95.6%
		Negative: 3.4%	Negative: 1.1%

post-test probability < 1% represents an acceptably low risk.

Conversely, in a high prevalence setting—e.g., on 3 July 2020, Quebec reported a test positivity of 9%, with a rate of 6,560 positive cases for 72,679 tests per 1,000,000 population—the interpretation of test results may be very different. Assuming a pre-test probability of 10% (representing a high prevalence of disease), a first positive test yields a post-test probability of 60.9%, while a negative test gives a post-test probability of 3.4%. A single negative test in a high pre-test probability scenario cannot rule out SARS-CoV-2 infection. Assuming that a second test is considered mutually exclusive from the first test, a second negative test would result in a post-test probability of 1.1%.⁵

Thus, the above examples illustrate that the utility of a SARS-CoV-2 NAAT depends on the local epidemiology of disease. In the preoperative context, test results that significantly impact the post-test probability of disease lead to clinically relevant decisions and are immediately actionable. Cancelling a non-urgent surgery because of a positive preoperative screening SARS-CoV-2 NAAT can avoid exposing operating room personnel and prevent nosocomial transmission of disease. A negative test that reduces the post-test probability to an acceptably low risk of disease can guide the safe discontinuation of isolation precautions, both intra- and postoperatively. Where the probability of disease is not effectively ruled out by an

initial negative test, a second negative result may add value in classifying true disease status.

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