False positives or negatives and their impact on mass testing

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A Royal Caribbean International ship cut short its four-day cruise to nowhere and returned to Singapore after an 83-year-old man on board tested positive for Covid-19. The man was taken on Wednesday afternoon to hospital, where his original sample was retested at a national laboratory and found to be negative for the coronavirus.

A fresh sample tested by the lab also returned negative on Wednesday, a result confirmed yesterday in a final test, indicating the result on board the ship was a false positive. The Straits Times looks at what false positives are.

Q: What is a false positive or false negative test result, and why do they occur?
A: A false positive test result means a person is wrongly diagnosed as infected, while a false negative means a true infection is missed. They occur as there is a margin of error in all Covid-19 tests, and none is accurate all of the time.

Q: How likely are false positives or negatives?
A: Sensitivity and specificity are the two measures of accuracy for Covid-19 tests. Sensitivity refers to a test’s ability to identify those infected as positive. A test with lower sensitivity will have more false negatives, meaning more true infections are missed. Specificity refers to a test’s ability to correctly identify those not infected as negative. This means a test with lower specificity has more false positives.

The default test used in national laboratories is the polymerase chain reaction (PCR) test. It has a sensitivity rate of more than 93 per cent and a specificity rate of more than 95 per cent, but it can take up to one or two days for results to be out. Antigen rapid tests are faster, taking only about 15 to 30 minutes for results to be ready. These have been used for testing before large-scale events, and have a sensitivity rate of 82 per cent and a specificity rate of 99 per cent.

Q: Can the same test sample yield different results?
A: Yes. First, because of the varying sensitivity and specificity of each type of test, subjecting the same sample to different testing protocols can give different results. Professor Teo Yik Ying, dean of the National University of Singapore’s Saw Swee Hock School of Public Health, said it is possible the testing regime in some corporate settings may use point-of-care tests or antigen rapid tests, which are able to deliver a result more quickly but tend to have a higher error rate.

It is thus possible for some of the less accurate protocols to yield erroneous findings when the same sample is tested using different testing protocols.

Second, the coronavirus enzymes that might be present in a person’s swab sample are susceptible to degradation in the hostile external environment, said infectious diseases specialist Leong Hoe Nam. So, a sample which tested positive earlier may test negative in subsequent tests.

Q: What are the testing capabilities on board cruise ships, and how do they differ from those of national laboratories?
A: Mr Michael Goh, head of international sales at Genting Cruise Lines and president of Dream Cruises, said last month that its safety regime includes a new real-time PCR machine on board that yields Covid-19 test results in 60 minutes. Royal Caribbean also has something similar on board.

While both liners did not reveal the accuracy of the testing machines on their ships, Mr Goh said yesterday that the PCR machine on Genting’s World Dream was approved by the Health Sciences Authority, and PCR tests “remain the most accurate test available today”.

Dr Leong said the accuracy and precision of the machines on cruise ships are likely to be lower than those of the Health Ministry laboratories, but they are still useful within the scope of what they can do.

Q: What does the likelihood of false positives mean for mass testing as large-scale activities resume progressively?
A: With no test able to be completely accurate, experts said it is important to learn how to cope when errors occur.

Prof Teo said: “The reality is that, as testing becomes more prevalent, erroneous results will emerge. These will have knock-on effects on whether a traveller is incorrectly denied entry or participation, or whether someone who is genuinely infected is missed and ends up seeding additional cases in the community.”

“Of observed positive findings, especially when diagnosed within 72 hours of testing, it may be worth undergoing a round of retesting, preferably with an independent testing protocol to avoid any systematic errors. This way, we avoid the false scares that can happen, such as what happened on the Royal Caribbean ship.”

Dr Leong said retesting capabilities may not be available on ships, as these tests are usually done by lab experts in consultation with infectious diseases experts. As a result, he said, the captain’s decision to turn back on Wednesday morning was a prudent one.

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