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Medical tests and probability math ia answers pdf online

That would mean of 100 people infected with SARS-CoV-2, 80 of them would have positive tests and 20 would have negative tests: Covid-19: Yes Test Positive 80 Test Negative 20 Total 100 advertisement Since many of the tests report 100% specificity, let's go with that estimate, even though there have been reports of possible false positive tests. So 8 will have a positive test, and 2 will have a negative test: Covid-19: Yes Covid-19: No Total Test Positive 8 Test Negative 2 Total 10 990 1000 Of the 990 people without Covid-19, 100% of them will have a negative test because the specificity is 100%. Thus, the backward conditional probability that you have the disease given that your test is positive is given by $\frac{{1800}}{{6700}} \approx 0.2686567$; ${\textrm{P}}\left({D\left| {Pos} \right.} \right) \approx 0.269$.Here is the calculation of ${\textrm{P}}\left({D\left| {Pos} \right.} \right)$ using Bayes' theorem:${\textrm{P}}\left({D\left| {Pos} \right.} \right) = \frac{{{\textrm{P}}\left(D \right) \cdot {\textrm{P}}\left({Pos\left| D \right.} \right)}}{{{\textrm{P}}\left(D \right) \cdot {\textrm{P}}\left({Pos\left| D \right.} \right) + {\textrm{P}}\left({ \sim D} \right) \cdot {\textrm{P}}\left({Pos\left| { \sim D} \right.} \right)}} = \frac{{0.02 \cdot 0.9}}{{0.02 \cdot 0.9 + 0.98 \cdot 0.05}} \approx 0.2686567$${\textrm{P}}\left({D\left| {Pos} \right.} \right) \approx 0.269$ says that if your test is positive there is only about a 27% chance that you have the disease. Some recent studies have attempted to do this, but the results have varied widely – giving prevalence rates from around 1% up to 28% (granted these studies have been conducted in different populations/countries). Keep in mind, though, that 2% represents tests in people with and without symptoms, so it is likely higher by at least 2-fold (and maybe more) compared to testing only those without symptoms. This challenge is determining an accurate measure of what proportion of a population is currently infected with the novel coronavirus (i.e. the prevalence rate). The more prevalent the disease, the more you should trust a positive test. So we estimate the pre-test probability as 1% in this group of asymptomatic Massachusetts residents. We need to seriously consider the probabilistic realities of medical testing - especially the concepts of false-positives and false-negatives.Firstly, it will help to clarify some of the terminology often used when discussing the current virus pandemic. Of 1,000 of these patients being tested, 300 will have Covid-19 and 700 will not: Covid-19: Yes Covid-19: No Total Test Positive Test Negative Total 300 700 1000 Based on the sensitivity and specificity of the test, 80% of those 300 (240) with Covid-19 will have a positive test, and 100% of those 700 without Covid-19 will have a negative test: Covid-19: Yes Covid-19: No Total Test Positive 240 0 240 Test Negative 60 700 760 Total 300 700 1000 Calculating positive and negative predictive values: Covid-19: Yes Covid-19: No Total Test Positive 240 0 240 Test Negative 60 700 760 Total 300 700 1000 Positive predictive value = having Covid-19 if the test is positive = 240/240 = 100% Negative predictive value = not having Covid-19 if the test is negative = 700/760 = 92% SARS-CoV-2 is a new strain of coronavirus that has not been previously identified in humans.Here are some other important terms associated with the mathematics (namely, probability) of medical testing.■ Prevalence rate (or base rate): The prevalence rate for a virus infection is the proportion of people in a population that are infected with the virus. There is a test with a 0.9 probability of giving a positive result when a person has the disease (the test's sensitivity is 0.9), and a 0.95 probability of giving a negative result when a person does not have the disease (the test's specificity is 0.95). Also, it is worth noting that the word "rate" is often synonymous to "probability." For example, if the prevalence (or base) rate for the novel coronavirus was 5% in a certain population then if you randomly chose a person from the population the probability is 0.05 that the person is infected.■ False-positive and false-negative: According to the excellent book, The Art of Statistics: Learning from Data by David Spiegelhalter, a false-positive is "an incorrect classification of a 'negative' case as a 'positive' case." It follows that the reverse situation is a false-negative.Consider an example where a test is created to detect a disease. In this case, according to Spiegelhalter, there is a false-positive probability (or rate) of 0.05 because of the people that do not have the disease 5% of them will receive a positive test result; and a false-negative probability of 0.1 because of the people that do have the disease 10% of them will receive a negative test result. Why is this? However, I think the various probabilities related to this example are better illustrated by considering what would occur on average if a large sample of people, e.g. 100 000, are tested. See the table below.6700 received a positive test but only 1800 of them actually have the disease. Positive test result: Pos; Negative test result: Neg; person has the disease: D; person does not have the disease: ~ D. Experts have commented that the sensitivity of a test for SARS-CoV-2 is likely to be lower than the test's specificity because many of the tests are difficult to carry out sometimes causing the test sample of an infected person to be defective so the virus goes undetected.However, when it comes to medical testing the phrase false-positive (or false-negative) is not always consistently applied. If we strictly apply Spiegelhalter's definition of a false-positive as "an incorrect classification of a 'negative' case as a 'positive' case" then we should only call the forward conditional probability ${\textrm{P}}\left({Pos\left| { \sim D} \right.} \right)$ a false-positive. In the 'average' calculations for the sample of 100 000 shown above, the number of people who test positive and have the disease (1800) is significantly smaller than the number who test positive and do not have the disease (4900). During the height of the surge in April, this was roughly 30%. Unfortunately, we will not know how reliable the tests for detecting whether someone is infected with SARS-CoV-2 until we have a better grasp of the probability that a random member of a population is infected even though they may or may not have any symptoms associated with the Covid-19 disease.A colorized scanning electron micrograph of a cell infected with coronavirus particles, in yellow (National Institute of Allergy and Infectious Diseases, USA) Covid-19 test accuracy supplement: The math of Bayes' Theorem Example 1: Low pre-test probability (asymptomatic patients in Massachusetts) First, we need to estimate the pre-test probability that asymptomatic Massachusetts residents have Covid-19. Let the following symbols represent the indicated events. This is not exactly the same as the percentage of tested people who have Covid-19, but it's a good approximation. Determining whether or not someone is infected (or was infected and has developed antibodies) relies on some kind of medical test – and the results of any medical test are not certain. However, it is very common for the backward probability ${\textrm{P}}\left({D\left| {Pos} \right.} \right)$ to also be referred to as a false-positive. For 100% specificity, among 100 people without Covid-19, all 100 would have negative tests: Covid-19: No Test Positive 0 Test Negative 100 Total 100 Among 1,000 people of unknown Covid-19 status being tested, 1% will have the infection (from the pre-test probability). For our example, the false-positive probability of 0.05 is a conditional probability (in the SL and HL maths syllabus); it is the probability that your test is positive given that you do not have the disease. Is this a false-positive probability? Covid-19: Yes Covid-19: No Total Test Positive 8 0 8 Test Negative 2 990 992 Total 10 990 1000 Positive predictive value = having Covid-19 if the test is positive = 8/8 = 100% Negative predictive value = not having Covid-19 if the test is negative = 990/992 = 99.8% Example 2: High Pre-Test Probability (patients hospitalized with Covid-19 symptoms) First, we estimated the pre-test probability among patients at Brigham and Women's Hospital who presented with signs and symptoms of Covid-19, such as shortness of breath and fever. The sensitivity and specificity of the test remain the same as in Example 1: 80% sensitivity and 100% specificity (the test itself has not changed, only the group of people being tested). That is, ${\textrm{P}}\left({Pos\left| { \sim D} \right.} \right) = 0.05$. According to the European Centre for Disease Prevention and Control, Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) is the name given to the 2019 novel coronavirus. It is important to note that the prevalence rate for novel coronavirus infection will be higher than the prevalence rate for COVID-19 disease because not everyone who becomes infected with the novel coronavirus (SARS-CoV-2) develops the disease. This is the probability that you have the disease given that your test is positive, i.e. ${\textrm{P}}\left({D\left| {Pos} \right.} \right)$, which is 'backwards' in that it first takes into account your test result and then asks whether or not you have the disease. Although we are nearly three months into the global pandemic the data available on different aspects of the pandemic is patchy and unreliable. My apologies for another blog post (see 13 May post) which includes the words "virus" and "probability" but undoubtedly some interesting mathematical components are embedded in aspects of the current global pandemic.A recent mathematical model constructed by epidemiologists at Columbia University in New York City estimated that for every documented novel coronavirus infection in the United States, 12 more go undetected. At the moment, there are a few estimates for the prevalence rate for COVID-19 (the disease) in different countries but very little on estimated prevalence rates for infection with the novel coronavirus. 1% of 1000 is 10, so 10 will have the disease, and 990 will not: Covid-19: Yes Covid-19: No Total Test Positive Test Negative Total 10 990 1000 Of the 10 people with Covid-19, 80% of them will have a positive test because the sensitivity is 80%. Well, if a disease is not common then it is more likely that that your positive result is a mistake. Hence, the prevalence rate is a critical statistic when ascertaining how much we can trust a positive test result.Which leads directly to one of the biggest challenges facing scientists and politicians while they try to advise the general public how best to live with a new virus that some experts have said may infect every human on the planet unless an effective vaccine is invented. Typically, prevalence rates are estimated using other data. What about the backward conditional probability? I think that one of the reasons for this is because this probability is considerably lower than expected. For our example, it is counterintuitive that a test that detects the disease in people who have it with an accuracy of 90% (the test's specificity) can only give us a 27% probability that a positive test means we actually have the disease. In other words, all 990 will have a negative test: Covid-19: Yes Covid-19: No Total Test Positive 8 0 8 Test Negative 2 990 992 Total 10 990 1000 Now we can calculate positive and negative predictive values. This is what we might refer to as a forward conditional probability because it follows the chronological order that first you either have or do not have the disease and then you are tested. advertisement In terms of test characteristics, let's say the sensitivity of the rapid point-of-care test is 80%, as has been claimed for some of them. This type of backward conditional probability can be computed using Bayes' theorem (in the HL maths syllabus). We know that in the state approximately 2% of all tests for SARS-CoV-2, the virus that causes Covid-19, are positive. COVID-19 is the name given to the disease associated with the virus. It is established that the disease has a 0.02 prevalence rate. 80% times 10 is 8.

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