Perspective

Treadmill stress tests should not be part of "routine health check package"

A B S T R A C T

A treadmill ECG stress test (TMT) often forms part of the popular health check packages recommended for people who are asymptomatic on the premise that it can detect disease at an early stage and treatment be prescribed to prevent or reduce future morbidity and mortality. Such a recommendation does not take into account the properties of this procedure as a diagnostic test. It has an average sensitivity and specificity of 68% and 77%, respectively. However, these figures depend on the probability of coronary artery disease (CAD) in the test subject. In asymptomatic persons with few or no risk factors, the likelihood of a false positive is high and will result in psychological stress and/or expensive and possibly invasive test. Recommendation for a TMT should be made by a physician after evaluating the subject to have at least an intermediate risk of having CAD.

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Recently, a patient called me for advice about his 35-year-old daughter. The young lady was in good health, exercised regularly, did not smoke, and was careful about her weight. Being health conscious, she decided to have a "health check" and went to a private hospital near her home. She was offered a bouquet of packages and opted for one recommended as being comprehensive. This package apart from blood and urine tests, chest X-ray, abdominal ultrasound , and ECG included an echocardiogram (ECHO) and a treadmill ECG stress test (TMT). As expected, all her blood and urine tests, ultrasound, X-ray, ECG, and ECHO were normal, but she was told that her TMT was positive and indicated possible coronary artery disease that could result in a heart attack or even sudden death. She was advised to undergo either coronary angiography or coronary computed tomograohy (CT) coronary angiography. Neither of these naturally was included in the package. This was where her father felt a second opinion was needed. The TMT report was produced. The TMT tracing did indeed show a 1 mm down sloping ST segment depression in the inferior leads. It was noted that she had completed the target metablioc equivalents of task (METs) and achieved the target heart rate and had a normal blood pressure response. In addition, she had not complained of chest discomfort or any unusual symptom during the test. I advised the father to ignore the test as it was almost certainly a false positive test.

1. Sensitivity and specificity of a test

When evaluating any diagnostic test, commonly used parameters are its sensitivity and specificity. The sensitivity of a test reflects the proportion of people with the disease in question who are tested positive, whereas the specificity is the proportion of those without the disease who are tested negative. Sensitivity is calculated by dividing the number of people with disease who are tested positive (true positive) by the total number of those with disease who underwent the test. Conversely, the specificity is calculated by dividing the number of people without the disease who are tested negative (true negative) by the total number of those without disease who underwent the test. In the diagnosis of coronary artery disease (CAD), TMT has an average sensitivity of 68% and specificity of 77%[1] – Table 1. Such studies are usually done comparing the test with a gold standard. In the case of TMT, the gold standard is usually a coronary angiogram. However, figures derived from people undergoing coronary angiography may not be representative of other populations such as asymptomatic people having a TMT as part of a "health check" package. This is because the sensitivity and specificity of a test depends on the population in which it is tested. A higher proportion of people undergoing coronary angiography are likely to have CAD and in more severe forms such as triple-vessel disease. In such cases, sensitivity will be higher and specificity will be lower than those in a lower risk population.[2]

2. The predictive value of a test

Although sensitivity and specificity are common parameters for evaluating a diagnostic test, they do not really reflect clinical practice. In practice, a physician does not start with a patient known to have a disease and then do the test. Rather, she/he asks for the test in those in whom she/he suspects the disease but is not sure. Thus, she/he is more interested in the likelihood that a person who is tested positive truly has the disease of interest rather than the other way around. This more relevant information is reflected in the positive and negative predictive values of a test. The positive predictive

Table 1
Sensitivity and specificity of TMT in people with 25% prevalence of significant CAD.

TMT Result	People with CAD	People without CAD	No. of tests
TMT test positive	34	35	69
	True positive	False positive	Positive tests
TMT test negative	16	115	131
	False negative	True negative	Negative tests
No. of people	50	150	200

CAD, coronary artery disease.
Sensitivity 34/50 = 68%; specificity 115/150 = 77%.

value (PPV) of a test is the proportion of those testing with a positive who do, in fact, truly have the disease in question, and the negative predictive value (NPV) is the proportion of those with a negative or normal test result who are free of disease. The predictive value of a test is affected by the prevalence of the disease in the population being tested. The lower the prevalence of the disease in the test population, the lower the PPV of the test and the higher the NPV. Tables 2 and 3 show two scenarios. In Table 2, we see the results of TMT in patients referred for the test by a physician who suspected they may have CAD (high pretest probability), whereas Table 3 shows the outcome of TMT testing in patients who underwent the test as part of a routine "medical check-up" package with no prior screening. In the first case (Table 2), the prevalence of CAD in the group referred for TMT (high pretest probability) is 25%; in the second (Table 3), it is 5% (low pretest probability). The tables have been constructed using the average sensitivity and specificity of the TMT test i.e. 68% and 77%, respectively. Despite the same sensitivity and specificity, it can be seen how the predictive value of the test differs depending on the likelihood of the patients having CAD. If the test is ordered by a physician in only those people whose clinical features suggest a reasonable probability of CAD (25% in this example), the chances of a person testing positive actually having CAD is 49% (still a significant false positive rate), and if the test is negative, there is a 88% chance that the person is free from CAD. On the other hand, if the TMT is done routinely as part of say a health check-up package, the chances of people undergoing the test having CAD is much lower (here 5% i.e. 100 of 2000 people tested); the PPV drops to as low as 11% (a false positive rate of 89%), whereas the NPV is higher— 98% here. As a result, many people undergoing a TMT and getting a false positive will actually not have CAD, but to be sure of this, they will be advised either to have more and expensive tests such percutaneous or CT coronary angiography or to be started on treatment for CAD with resulting psychological trauma, unnecessary expense, and possible side effects

Table 2
Positive and negative predictive values of TMT in people with 25% prevalence of significant CAD.

Disease status	TMT test positive	TMT test negative	Total
People with CAD	34	16	50
People without CAD	35	115	150
Total	69	131	200

CAD, coronary artery disease.
Positive predictive value 34/69 = 49%; negative predictive value 115/131 = 88%.

Table 3
Positive and negative predictive values of TMT in people with 5% prevalence of significant CAD.

Disease Status	TMT test positive	TMT test negative	Total
People with CAD	68	32	100
People without CAD	570	1330	1900
Total	638	1362	2000

CAD, coronary artery disease.
Positive predictive value 68/638 = 11%; negative predictive value 1330/1362 = 98%.

Table 4
Pretest probability of CAD by age, gender, and symptoms with and without risk factors.[9]

Age (yrs)	Nonanginal chest pain		Atypical angina		Typical angina	
	Men	Women	Men	Women	Men	Women
35	3–35	1–19	8–59	2–39	30–88	10–78
45	9–47	2–22	21–70	5–43	51–92	20–79
55	23–59	4–21	45–79	10–47	80–95	38–82
65	49–69	9–29	71–86	20–51	93–97	56–84

CAD, coronary artery disease.
In each box, the number on the left is for people without diabetes, smoking, or hyperlipidemia, whereas the number on the right is for people of the same age with all three risk factors.

of medication. In fact, in studies. people who tested positive on a TMT but subsequently were found to have normal coronary arteries on invasive coronary angiography despite having no increase in coronary events or mortality had increased hospitalizations for "chest pain".[3,4] A caveat here is that the sensitivity and specificity used in these examples are the average figures for any test classified as positive. However, a strongly positive test (flat ST depression 2.5 mm or more, slowly rising ST depression with j point depression of 2 mm or more and a horizontal or down sloping ST depression in the first stage of exercise and remaining depressed for 8 min or more)[5,6] is likely to have a higher specificity and PPV even in an asymptomatic individual.

Furthermore, it is important to recall that a TMT will not detect nonobstructive atherosclerotic lesions in the coronary arteries. Yet it is known that acute coronary events may arise from rupture of such lesions.[7,8] This explains the phenomenon of a person with a "normal" TMT going on the have an acute coronary event or even sudden death, leading to consternation and embarrassment of the medical fraternity. In addition, in high-risk people, the NPV can still result in a signifcant number of cases with disease being missed (Table 2).

Thus, it is not advisable to include a TMT as part of a routine "health package". The advisability of such packages themselves is debatable. If at all they are to be carried out, such screening packages should focus mainly on screening tests for common disease and those in which it has been shown that such screening is beneficial—examples include blood pressure measurement, blood glucose/HbA1C, lipid profile, PSA in men aged 50 years and older, and a mammogram in women aged 45 years or older. A TMT should be ordered by a health professional if she/he feels that there is a reasonable chance of the concerned person having significant CAD i.e. the pretest possibility is intermediate. Table 4[9] shows the pretest probability of CAD in people of different ages with no chest pain, atypical chest pain, and chest pain suggestive of angina with and without risk factors. Where the probability of CAD is low, further testing by TMT has a high likelihood of a false positive. Conversely, in people in whom the likelihood of CAD is very high, it is better to proceed with a test with better diagnostic indices such as myocardial perfusion imaging, CT coronary angiography, or percutaneous coronary angiography. A TMT is most useful in those people with an intermediate pretest probability of 20%–70%. Such an approach will increase the utility and cost effectiveness of the test.

Conflict of interest

The author has none to declare.

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