Cardiac Stress Testing: What Is It? When To Use It?

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Dena Wilson:

Thank you all for logging in today. My name is Dena Wilson, and as Jan said, I am a Cardiologist with the Native American Cardiology Program. I'm originally from Pine Ridge, South Dakota, and a member of the Oglala Lakota Sioux Tribe. I attended medical school at the University of Washington in Seattle and completed my residency and fellowship at the University of Arizona in Tucson.

As Jan said, I'm a Board Certified in Internal Medicine, Cardiovascular Disease, Echocardiography, and Nuclear Cardiology. Currently, I'm practicing as a Non-Invasive Cardiologist with the Native American Cardiology Program here Flagstaff, Arizona. Mainly, I focus on providing clinical services to IHS and tribal facilities in Northern Arizona.

Just real quick, I'll do a little background on Native American Cardiology. Some of you may have heard of this program. It was started approximately 20 years ago in Tucson in collaboration with the University of Arizona. I joined the program in 2009, and in 2010 transitioned the program up to Flagstaff, like I said, providing clinical services to Northern Arizona.

So that's a little background about myself. Our talk today is cardiac stress testing. What is it, when to use it. This is a difficult talk given everyone's different background, so I'm hoping to apply it to everyone. So let us begin.

First of all, I just wanted to make sure everybody understands, I have no conflicts of interest, and the references are the ACC/AHA guidelines, and the appropriate use criteria for multimodality to cardiac testing. You can find this online at www.acc.org.

So our outline today, first, we're going to define cardiac stress testing and some of the terminology we use with cardiac stress testing. We're going to then discuss the different modalities in detail, and then we're going to discuss the appropriate and non-appropriate uses of stress testing. Lastly, we will finish up with some clinical scenarios to help put everything together and hopefully leave time for some questions.

So let's start by defining cardiac stress testing and discussing the terminology. It's very important to reference stress tests appropriately and many of you may think, "Oh, what's the big deal? It's a stress test." But it actually helps in communication with patients and providers. One of the most important things is when you reference a stress test, it's always important to start out by describing the stress and then the test. I like to have people avoid using radioisotopes as the stress portion, for example, valium nuclear test. The reason -- we'll talk about that later, but it doesn't tell me what kind of stress. It tells me the imaging study and the radioisotope, but it's important to understand the stress portion. So for example, Dobutamine stress echo. There's the stress, the Dobutamine; echo is the test. Again, like I said, the reason this is important is it really helps avoid confusion between patient and provider and providers, and it helps the communication between providers.

So in order to properly describe a stress test, it's important to understand what it is. I think when you don't do this on a daily basis; you don't really understand exactly what it is other than that you're going

to put the patient's heart under some stress. So we're going to talk about stress testing, but first, I want to explain that a stress test is a baseline evaluation. So you can use an ECG, echocardiogram, or nuclear perfusion imaging as your baseline evaluation. This is usually compared to a stress evaluation, whether that stress is performed with exercise or a pharmacologic agent, such as vasodilators or Dobutamine. Pacing is also a form of stress testing. This is pretty advanced, rarely used, and I would leave that up to the cardiologist to make that decision.

So once you have your baseline evaluation, you then have your stress evaluation. You're going to make a comparison of the rest versus the stress. And really, the goal is to detect a decrease in myocardial perfusion. Again, a baseline, a stress, and a comparison of the two looking for decreased myocardial perfusion.

Cardiac catheterization is not a stress test. Cardiac catheterization is basically visualization of the coronary anatomy. It does not give any functional information. So if a patient is referred for a cardiac catheterization, they may have a lesion in one of the epicardial arteries, but I don't know, based on that cardiac catheterization if there's ischemia or lack of blood flow to that territory, because again, it's just visualization.

Coronary CTA is also not a stress test. Again, this is a noninvasive visualization of the epicardial coronary arteries, not providing for any functional information as to whether or not there's decrease in myocardial perfusion. Coronary calcium score is also not a stress test. This estimates the calcium in the arteries, and it gives a risk assessment, but again gives no functional information.

An echocardiogram is not a stress test. An echocardiogram is a baseline evaluation that can be used in stress value testing, but in and of itself only provides us with information of the anatomy of the heart, so we're looking at valves, wall motion, we can look at pressures, but we can't really look at myocardial perfusion without a stress portion.

Next slide, here, is kind of hitting what I've been talking about with the description of a test; a stress versus the test. So in the left column, you have the stress: exercise, Dobutamine, vasodilators, which there are three different types that we use; Regadenoson, also known as Lexiscan, Adenosine, and Persantine. I also put pacemaker in this category because like I said, it can be used as a form of stress, but it's very seldom and rarely used. We would never put a pacemaker in a patient in order stress them. They would already have to have one. So we're not going to really talk about that today.

In terms of the test, Electrocardiogram, Echocardiography, Nuclear Myocardial Perfusion Imaging are the most common modalities. Positron Emission Tomography, also known as PET, and cardiac MRI are also forms of stress imaging. However, those are used mainly in large university settings and research settings. So again, for the purpose of this talk today, we're not going to talk about those.

Now, that we've simplified this slide, as you can see, exercise can be used as the stress for ECG, echocardiography, and nuclear myocardial perfusion imaging. Dobutamine is not used alone with ECG, but is commonly used in echocardiography and nuclear myocardial perfusion imaging. The vasodilators are not used for ECG testing alone and/or echocardiography, but are most commonly used with nuclear myocardial perfusion imaging.

Now, that we've kind of defined what the stress tests are and how to use the terminology in describing them, we're going to go into discussing each modality. As I mentioned earlier, the most accessible modalities are the exercise treadmill test, also known as the "Treadmill Exercise Test". The exercise stress echocardiograms, and the Dobutamine stress echocardiogram, exercise nuclear myocardial perfusion imaging as well as pharmacologic myocardial perfusion imaging.

Stress MRI and PET are not common modalities. As I mentioned earlier, they're usually used in larger university settings. I also put CT Coronary Angiography on this slide, although this is not a stress test,

as I mentioned earlier. The reason I put this on the slide is because often times, this is used in some ER settings for chest pain evaluation, and I think that that at times can confuse providers as well as patients. Again, this does not provide us with a stress or a functional study. This is a visualization of coronary anatomy. So it quickly rules out if a patient has a large thrombus, but it doesn't tell us anything about the functional status, their myocardial perfusion.

So in talking about the stress test, we're going to start with the most simple and basic stress test out there, and that's the exercise electrocardiogram. As I mentioned, also known as the exercise treadmill or TMET. This involves walking on a treadmill. A bike can be used, but it's rarely used in the United States. This is a comparison of a rest-ECG with a stress-ECG. So obviously, a patient should have an interpretable ECG for that comparison to be made. Patients who have baseline ECGs that have left bundle branch blocks, Wolff-Parkinson-White pattern, ST depression greater than 0.10 millivolts, digoxin use, or ventricular-paced rhythm should not undergo an exercise stress test, because the underlying ECG is not interpretable with exercise.

Also, patients have to be able to exercise safely; not just exercise, but exercise safely. So I often will, when I'm deciding on whether or not a patient can exercise, I'll have them do a hall test. I'll just have them walk down the hall and back up at me as fast as they can. If they do that without wobbling, I usually think that they're safe for a stress test.

So an exercise stress test that's supervised by a physician provides just invaluable clinical information. The patient comes into the lab, and usually, we listen to their heart and lungs and make sure that there are no very loud murmurs to indicate something like aortic stenosis, get a blood pressure and make sure that they're not hypertensive, and then the patient is hooked up to the ECG machine. The most standard protocol that we use is the Bruce protocol, or often the modified Bruce protocol. What this entails is the patient will exercise starting at 1.7 miles per hour at a 10% grade. This will increase every three minutes, the blood pressure, we monitor two minutes into each stage.

Some of the things we look for during the stress test include exercise duration. So how long can the patient exercise? One minute, six minutes, the longer they can exercise, the better prognostics indicator it is. We also look for heart rate achieved. So we want to hit 85% of the max predicted heart rate. If a patient can't get there, we start to worry about chronotropic incompetence. It's a good test that's also used for symptomatic bradycardia.

Exercise ECG also provides us with evaluation of arrhythmias, so PVCs, PACs, atrial fibrillation, SBTs, all of that can be evaluated. The METs and double products are also monitored throughout the test. Patients' heart rate recovery post-exercise is also an important piece of information within one minute which helps us to predict one; their exercise capacity, but also it's a poor prognostic indicator when a patient cannot get 20 beats below within one minute, so we do look at that.

The sensitivity and specificity, the sensitivity for an exercise ECG is about 45% to 67%, and the specificity is 72% to 90%. The ECG doesn't localize disease. We'll talk about that more when we talk about the myocardial perfusion imaging and the echo. But exercise ECG, like I said, is the most basic test. It's easily done, easily performed; it can be performed in rural settings. One of the things that's great about it is that it can be combined with imaging to increase the sensitivity and specificity of the test itself. So in combining it with exercise echo, so what we do here is we get a baseline echocardiogram, and this should be within normal limits. Patients who have known wall motion abnormalities, they should not be referred for exercise echoes because it makes it very difficult to assess this stress portion when the baseline is abnormal.

In this setting, we use the standard treadmill protocol, either the Bruce or the modified Bruce. The patient is hooked up the same way and monitored exactly the same way as with the exercise. The only difference is they do get baseline images, prior to. The patient will exercise to reach 85% of their max heart rate and then they lay quickly on the table back into left-lateral position so that post images can

be obtained. These post images should be obtained within 60 seconds and require an experienced sonographer, as well as patient cooperation. A lot of times, after the stress, the patient is breathing hard, the respiratory rate's up, and it's very difficult to see the endocardial borders. We could add contrast agents such Definity to help us outline the borders, but it still requires patient cooperation, and a lot of times, we'll have to have patients blow out and hold. Can you imagine doing that when you just did 10 minutes of exercise on the treadmill? It's challenging.

So when this isn't possible, when a patient cannot exercise or you don't think that they can cooperate with breath holding, or have underlying lung disease that would prevent them from doing that, we can always move on to the Dobutamine stress echo. This is used for patients who cannot exercise or patients who have underlying lung disease in which their lung volumes would cause problems getting the echo images. The nice thing about Dobutamine, like I said, is the stress without having the respiratory issues. It is a positive inotrope and chronotrope so we do have to be aware of arrhythmias or patients who are prone to arrhythmias. I've definitely sent patients into atrial fibrillation and I've canceled tests in patients who had a history of v-tach.

With this test, the patient comes in, we do a baseline echocardiogram, just as with the exercise echo, and then an IV is placed. The Dobutamine infusion usually starts at 10 mcg/kg/min, increases by 10 every three minutes to max of 40. The target heart rate is not always achieved with Dobutamine alone, at which point we can use atropine if there are no contraindications.

Dobutamine does have side effects. Patients will feel nauseated, flushed, have headaches. They feel like they need to urinate but these are very short acting effects. Once the Dobutamine is turned off, within three minutes, the patient is back to baseline. Like I said, the Dobutamine is a good study. It's a good agent to be used in patients who have underlying lung disease that would prevent them from participating with the exercise echo.

The next test that we commonly use is the exercise myocardial perfusion imaging study, also known as exercise nuke. This uses radioisotope valium and technetium. I get a lot of referrals for valium nuke or technetium nuke, which is not proper description. We don't usually know what facility uses what radioisotopes. The most commonly used is technetium.

Rest stress is the common protocol here. What I mean by that is the rest images are obtained and then the patient is stressed, and then the stress images are obtained. So the patient will come in. Again, an IV is placed and the patient will be injected with a radioisotope. This usually circulates for about 45 minutes before the first rest images are obtained. The patient will be then hooked up, in this case because it's an exercise. They are hooked up to the treadmill just like they were in the beginning with the regular treadmill exercise test, and the same Bruce or modified Bruce protocol will be used. When patient reaches 85% of their max heart rate, they're injected with a second radioisotope dose. With exercise, they exercise one minute after the injection. So I usually tell patients, "Please let me know one minute before you cannot exercise." I'm also monitoring the patient. I will talk to them so that I get a general idea of what their perceived exertion is, and there have been times where I've had to tell the tech to go ahead and inject the isotope because I knew that the patient wasn't going to last much longer than the minute, so paying attention to your patient is important.

This test has similar sensitivity to exercise stress echocardiogram. However, it can localize coronary disease. So once the patients finished the exercise, they have the stress images, and we compare again the rest and stress images. What we're looking for is decreased myocardial perfusion. If it's in the lateral wall, we can localize that to the circumflex anterior wall, LAD. So it's a good test to use for patients who have known coronary artery disease, who you're wondering whether or not they have a significant stenosis that's causing ischemia and where that's located. Patients with left bundle or paced rhythms have increased false positive rates, so with these patients, we do prefer pharmacologic agents. It will never fail. A patient with left bundle or pace rhythm will have a septal wall motion abnormality on the profusion images and we usually try not to let these get through with exercises, but it does happen.

The pharmacologic nuclear stress, most commonly uses vasodilators, and so instead of the patient undergoing the treadmill, they're just injected with the vasodilator. Regadenoson, also known as Lexiscan is the most commonly used. This is an injection that occurs over one minute, followed by flush, and then followed by the radioisotope. The downside of this is that the patient has to wait 45 minutes before they can be scanned for their stress images, whereas in the exercise portion, they can go directly into stress imaging. So it does prolong the test by approximately one hour and it doesn't provide with the same information that the treadmill provides. The side effects of the vasodilators are heart block of varying degrees, bronchospasm, and hypotension.

If patients have underlying heart block, Dobutamine is always the other option for pharmacologic in the nuclear MPI and also bronchospasm. If patients have known bronchospasm, I would prefer to use Dobutamine in that setting. Vasodilators should not be used with caffeine because they use the same receptors and so if a patient comes in, had a cup of coffee, and didn't tell us, it can be a false negative study. So we're very careful about asking about any type of caffeine use. With Lexiscan, 12 hours. Adenosine or dipyridamole, 24 hours.

So that is the most common modalities that we use. Now, that we've talked about those, we've talked about stress testing terminology. Let's talk about the appropriate use and inappropriate uses of stress testing. It's very difficult to give this portion of the talk, because, one, each patient is an individual and each case needs to be taken into individual consideration for what test is appropriate for that patient. We're not going to talk about what patient needs what test or what test is better. We're just going to go over some risk factors and pretest probabilities.

Who gets a stress test? Who's the most common person who is referred for a stress test? Well, it's those who we're wondering about whether or not they have coronary artery disease or what their risk is. We also see patients for the evaluation of arrhythmia, syncope, pre-op evaluations, exercise prescriptions, evaluation of cardiomyopathies, post MI. But for the purpose of this talk, we're going to focus on the detection of coronary disease and risk assessment.

The most common patient that I see is a patient who is presenting with chest pain. So what are we concerned about there? We're concerned about whether or not this patient has coronary artery disease. Are they high risk for having a cardiac event? So does this mean that every patient who comes in should have a stress test? No. That is where we have to consider different aspects and one of the things is we talk about pretest probability of coronary disease. We've heard about this since the beginning of school. What is the pretest probability? The pretest probability is important because low pretest probability patients are unlikely to benefit from stress testing due to high false positive rates.

Intermediate risk patients are the ones who benefit the most and high-risk patients don't benefit because they have a high likelihood of coronary artery disease. So if our question is whether or not this patient has coronary artery disease and they have a high pretest probability, we don't need a stress test to tell us that. So, there are some indications for low risk and high risk testing. Exercise ECG is really the only appropriate test that we use for low pretest probability patient with symptoms. Exercise ECG is also acceptable for asymptomatic high pretest probability patient. When we go through our case scenarios, we'll put this together a little better.

So pretest probability is based on clinical history, age and sex, and risk factors for coronary artery disease. We can also use some of the global risk scoring calculators to help us risk assess a patient, but the risk assessment and pretest probability are a little different, and we'll go through that here.

First of all, clinical history. Like I said, patients usually come in presenting with chest pain and we need to decide what, if they need a test. One thing is to get a good clinical history, sometimes that's not the easiest thing to do, and to understand what that clinical history means. So angina. There are three types of angina, typical angina is sub sternal chest pain or discomfort that's provoked by exercise or emotional stress. It's relieved by rest or sublingual nitroglycerin. Atypical angina is chest pain or

discomfort that lacks one of the characteristics of the typical angina. A non-anginal chest pain is chest pain that meets one or none of typical angina characteristics.

Like I said, in our patient population, sometimes it's really hard to get a good history. Actually, just this morning, a patient told me, "Well, it feels some way." "Does it feel some way when you exercise?" "Yes, sometimes." "Okay. Does it get better when you rest?" "Sometimes, but sometimes it gets better when I walk too." So, I do understand it's hard sometimes to get a clinical history, but really, we try to focus on when patients describe the chest pain. Is it exertional? Is it relieved by rest or sublingual? When I can get a typical angina history, I know that patient that put them in a higher pretest probability category.

Next is age and sex. Age and sex do matter when it comes to pretest probability. As patients get older, they have an increased likelihood of coronary artery disease. This is the standard Diamond and Forrester pretest probability chart. I don't know if anybody is familiar with this. It's a confusing chart and it didn't show up as great as I wanted it to on this. Basically, it's showing that as people gets older, their risk increases. But we're also seeing that patients are having disease younger and younger, and women's symptoms are different. So, non-anginal chest pain could potentially in women could present as their angina. So this was what we were taught on. My goal here is to say that this isn't always applicable anymore, especially in the setting of diabetes.

So now that we've talked about the clinical history, age and sex of pretest probability. The traditional risk factors for coronary artery disease should be assessed to whether or not the patient has diabetes, whether or not they use tobacco, hypertension, hyperlipidemia, peripheral arterial disease, and the family history of premature coronary artery disease, father less than 55 and mother less than 65.

In the global risk scoring calculators, such as Framingham, the Strong Heart, and CVD risk calculator. Family history is not included, but I always include family history. I think it gives us additional information into the patient's risk factors. I recently had a 21 year-old old, 21 year-old, who came in with non ST elevation MI and a 75% LAD lesion. So like I said, things are changing. So now, that we've looked at the pretest probability of the patient and have determined that they are appropriate for cardiac testing, and then we ask ourselves, do they have any conditions that preclude them to having an exercise or pharmacologic stress test? Given the fact that they don't and we're moving on, but then we then have to ask ourselves, what if anything will change in the management of this patient based on the results?

I think that this is really, really important to think about because stress testing is not benign. Cardiac testing is not benign at all. Cardiac testing leads to downstream testing, and you need to think about that and your patient needs to understand that as well. So this isn't just one thing and game over, it's done. There are downstream effects of cardiac stress testing. Some of the things that I've seen in practice is that patients get very stressed of the unknown, especially if as a provider, you tell the patient, oh, they're going to get a stress test, and that's it. They don't know what that means. I've had patients call up and actually cancel their appointment because they don't why they're coming. I've had one patient recently who was in tears when I walked in the room and I asked her what was wrong and she's like, "I don't know what you're going to do to my heart." I felt very bad for her. So we spent some time talking about it and she was fine but this can cause a lot of stress on patients. The heart, people worry more about the heart than just about any other organ. So being able to talk about the stress test, describe it to them, inform them of why it's happening is very important.

You also need to decide what to do with the results before you're ordering the test. A patient has creatinine of five and is not wanting dialysis, gets positive stress tests. Well, the next indication is a cardiac angiogram but with the creatinine of five, the risk for dialysis is extremely high. So this needs to be talked about prior to the testing. If there's uncertainty, talk to the cardiologist because there are ways to work around some of this, but you need to be involved as well as the patient needs to be involved with what happens with the results. An 85-year-old who's not very functional, do we send

them for a coronary artery bypass grafting based on the results of the test? So like I said, downstream effects need to be considered as well as patient compliance.

I think it's very, very important to assess compliance and note it in your notes as primary care doctors. "This patient is very good with taking medication. This patient understands." Because, again, the downstream effect, a positive stress test can lead to a stent. Stent requires antiplatelet therapy and without that you can block the stent. So patient compliance is very important. I think by not only just understanding pretest probability in assessing who needs a stress test, you also have to look at what we're going to with that information and is the patient onboard with this plan, does the patient understand and want to proceed forward with that.

Now, we kind of touched quickly on who is appropriate for a test, who's not appropriate for a test. Anybody who's being routinely screened and is asymptomatic is inappropriate. There should be no routine screening and like I said, the reason being is because testing isn't benign. A false positive and a cath and a CVA, those aren't good things. Asymptomatic or stable symptoms with the last testing within two years, including cardiac cath. Normal prior stress testing with low to intermediate risk patient within two years. Asymptomatic less than five years post CABG or two years post PCI.

Just the other day, and a patient call me up and he said, "I'm due for my stress test." I said, "You're due for your stress test? What do you mean?" He's like, "Well, I had a heart surgery last year, so I have to have a stress test this year." I said, "Well, that's not true." It's an inappropriate use of stress testing. Then, we didn't talked about pre-op because it's a talk in and of itself, but patients who can perform more than four METS, do not need a stress test and patients with no clinical risk factors do not need stress testing.

So special circumstances, diabetes is a coronary heart disease equivalent. The coronary calcium score is a 2A indication for diabetes risk assessment. Coronary calcium scores greater than 400, may indicate an appropriate use for stress MPI. Patients with higher hemoglobin A1Cs have been associated with elevated risk of cardiovascular disease in asymptomatic people.

The reason I bring this up is because I think the question always comes up of, what do we do with our diabetic patients who are asymptomatic? How do we know that it's not silent ischemia? I think there are probably many of you in the audience today who know more about the DIAD Trial than I do, but the outcomes haven't been very different in terms of routine screening in asymptomatic diabetic patients, but coronary calcium scores have been shown to be of clinical use, like I said, with scores greater than 100, it may be appropriate to do stress testing at that time. Like I said, in my practice, when a patient comes in with hemoglobin A1C of 14 versus that of 6.5, I'm a lot more concerned about the patient with the 14 over the 6.5.

Now, that we've done that, let's put some of this together through some clinical scenarios. It's going to be a little weird because we're doing this webinar style, so what I'm going to do is read off a question and give you a few minutes to just think about the answer and then I will discuss the answer.

Question number one: a 50-year-old female with hypertension has a chest pain with some typical and atypical features of angina, baseline ECG is normal, she can exercise. What test is appropriate? Perfusion PET imaging with rubidium and FDG for viability; adenosine nuclear MPI with technetium 99; exercise ECG; or dipyridamole echocardiography. So with this, A is not correct, one, because we didn't talk about it. But two, this is a viability study. We don't even know if this patient has disease yet. B, adenosine nuclear myocardial perfusion imaging. Well, the patient can exercise, so why would we do a pharmacological test and miss out on all of that invaluable clinical information I talked about earlier. C, exercise ECG, this is the correct answer. We'll talk about that in a second. Dipyridamole echocardiography; well, like I said earlier, we don't use vasodilators with echocardiography testing.

So exercise ECG, I know everybody is probably thinking, well, women have a high false positive rate with ECG alone. And this is a debate in cardiology, has been and always probably will be, of what to do with women. This woman has hypertension and some typical/atypical features of angina. I think it's appropriate to start with an exercise ECG in this female. If she had diabetes with atypical and typical features, I would probably be more inclined to add-in the imaging study, just to increase my -- as I said earlier, sensitivity and specificity, but I think the appropriate answer here would be exercise ECG.

Question number two: a 45-year-old active male with atypical chest pain, hypertension, hyperlipidemia, family history, and left bundle branch block, which test do you order? A, Regadenoson nuclear MPI; B, exercise echocardiography; C, exercise nuclear MPI; or D, cardiac catheterization. So with this patient, multiple risk factors, but he has a left bundle branch block. So what we talked about earlier is left bundle branch block, exercise ECG in an uninterpretable baseline, ECGs uninterpretable. We don't usually use that, so a Regadenoson nuclear test would be best. I'm sorry, exercise nuclear MPI would be best. Sorry guys, Regadenoson is the correct answer. Exercise nuclear MPI would be incorrect because of the left bundle branch block. He will have a septal abnormality. So, again, pharmacologic agents are preferred even in a patient who can exercise, because he has the left bundle branch block.

Question number three; a 78-year-old obese female with osteoarthritis of the knees, needs non-cardiac surgery, she cannot complete four METs, which test do you order? Dobutamine stress echo, exercise ECG, Lexiscan nuclear MPI; either A or C. So we know she can't exercise, she has arthritis of her knees. So answer B is not correct. She could, however, have either pharmacologic test of the Dobutamine or the Lexiscan. As an obese female, she is going to have difficulty with either imaging studies and obtaining the baseline and stress images, but either A or C will be correct.

One more question and then we can get to your questions. A 55-year-old male with diabetes, peripheral vascular disease, hypertension, hyperlipidemia, has angina with minimal exertion, what stress test do you order for the diagnosis of coronary artery disease? This here is a trick question. As I talked about earlier, high risk patients don't need a stress test for the diagnosis of coronary artery disease. This patient has coronary artery disease and should be treated, because of the angina, proceeding directly into cardiac angiogram -- I mean, cardiac catheterization would be appropriate. You can also do a stress test to risk stratify and see where, like I said, localize where the disease process is but in a patient whose first time doesn't have grafts, proceeding on with cardiac catheterization is probably the right thing to do here.

Thank you very much for my very first webinar and like I said, I know that this is a lot of information in a short amount of time, so we can take some questions I think.

Jan Frederick:

Thank you Dr. Wilson for a great presentation. Kelli captured the questions from our participants for you. Do you want us to read those or do you want to read those and answer them as you go?

Dena Wilson:

So, I can read one. Is there a possibility to move the question tracker over a little? It's not all the way on my screen. Thank you. So question number one, Dawn. I've worked with people who've had exercise ECG stress test. The test was stopped. The patient was given nitro and a cardiac cath schedule. Patient was anxious while waiting for cath, had the cath and was told it was a false positive and more common for women. One in four as memory serves. Should a patient be told a false positive stress ECG test? Should a patient be told?

Yes. I mean, a patient should be told. I usually, like I said, talking to patients and involving them with the decision process of stress testing is important. I do tell my patients, my female patients that there is a possibility of a higher false positive rate. For a woman, I guess, when the ECG is positive alone on

just an ECG, I would probably move to an imaging study. Now, given the fact that this patient was symptomatic, to the point where they needed nitro, I think the appropriate thing to do was to send her to cath and the fact is that it's a false positive test and that is what happens. So that's again why we talk about involving patients in our decision making process behind stress testing, so that they're aware that these things can happen.

Question number two, what is appropriate as far as adenosine stress test with patient with fluid retention and weight gain post CABG, 17 months? First of all, I guess, I didn't mention this, but when a patient's coming in for a stress test, whether it's a post MI, post CABG or new onsite heart failure cardiomyopathy. Patients need to be medically managed first and I think that's really, really important. So if a patient's volume overloaded, I will not stress them. One, it leads to false positive reads. It makes it very hard to get the post images, especially if they have edema in their stomach. So the patient should be medically managed first before they're sent for a stress test. I don't know if that answered the question, Leanne. I'm sorry.

Next question is, what about patients with strong family history of cardiac disease that are asymptomatic themselves? That would be a low risk, low pretest probability, and a treadmill test could be appropriate for that patient. That's probably what I would do.