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Using Echocardiography to Complement Risk Assessment

**Announcer:**
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**Dr. Sadek:**
This is Ahmed Sadek again, Assistant Professor of Medicine at Temple within the Pulmonary Hypertension Group. And in this episode, we're going to talk about using the echo to complement risk assessment in pulmonary hypertension.

So I wanted to emphasize that, at its core, assessing risk in pulmonary hypertension is really about understanding not so much how high the degree of pulmonary hypertension is, but how well adapted the right ventricle is to pulmonary hypertension.

And so going through the progression here of pulmonary hypertension, initially, you have elevation and pulmonary vascular resistance. And the right ventricle adapts to this by increasing muscle contractility, and wall thickness, otherwise known as right ventricular to pulmonary artery pressure coupling. And eventually, in order to maintain stroke volume, the right ventricle starts to dilate. And when that mechanism fails, and we're not able to maintain stroke volume, then the heart rate increases to try to maintain cardiac output. And in the final stage, the cardiac output is not able to be maintained and now we have a reduced cardiac output and the right ventricle is completely uncoupled to the degree of pulmonary artery pressure elevation.

And so, the echo can provide a direct assessment of how well adapted the right ventricle is to the pulmonary artery pressures and the resistance. And on the left, you see this non-invasive four-quadrant approach in this paper by Saad Kubba group. And on the right, from that same paper, you see a combined noninvasive and invasive approach. So, you have three examples of patients. And I should mention here actually, that in the noninvasive approach, you have a TAPSE, which is your marker of right heart function. And that correlates with cardiac output on right heart catheterization. And then you have a marker of PVR by echo, such as RVOT pulse wave Doppler notching.

And then over here you have three examples of patients. You have patient A here who has a poor RV function measured by TAPSE. But a near normal PVR here, as demonstrated in A. And this patient has primary RV pump dysfunction. In other words, their mechanism of heart failure is not related to pulmonary hypertension at all. And then you have patient B here has a very high PVR as marked by the RV pulse wave Doppler, but good RV function. And this patient does have pulmonary hypertension, but his right ventricle has adapted to some degree to that elevation. And then finally, you have patient C. And you see patient C here has poor RV function with markers of elevated pulmonary vascular resistance. So patient C has pulmonary hypertension, has evidence of right ventricular PA uncoupling. And this patient, of these three, is most likely to benefit from PH-directed therapy.

And this study kind of demonstrates the power of right heart function estimates by echo. In this study, by Forfia Group, the TAPSE, when used as a dichotomous variable, TAPSE less than 1.8 compared to TAPSE greater than 1.8 is a stronger predictor of survival than PVR with a hazard ratio of 5.7 compared to a hazard ratio of 1.01 with regards to PVR. Talking outside of TAPSE, we can kind of look at other echo parameters which correlate with risk as defined by the 2022 guidelines. And high-risk features include a large right atrium, which is consistent with a right heart that's failing to adapt, as demonstrated in this echo image. A TAPSE PASP ratio that's very low,

which is a direct metric of the degree of RV pulmonary arterial uncoupling, and then the presence of moderate or larger pericardial effusion. And the mechanism of pericardial effusion in PH is felt to be due to impaired venous or lymphatic drainage due to high right atrial pressure. And you can see this demonstrated in this echo on the right as well.

Another thought to have about using the echocardiogram is in many ways, I find that it adds specificity to some of our noninvasive parameters which can be affected by other conditions. And just as examples here, WHO functional class is subjective and can be confounded by comorbid conditions. Six-minute walk distance can be confounded by comorbid conditions as well, such as obesity, joint pains from connective tissue disease. And then NT-ProBNP and BNP are more cardiac specific, but they are falsely decreased. They can be decreased in obesity, and they can be elevated in renal disease. So by using the echocardiogram, you can put some of those functional parameters in context of the degree of pulmonary hypertension.

And this study attempts to do just that. This mercurial group study looked at about 150 patients, divided them by traditional risk factor tertiles into low risk, intermediate risk, and high risk. And the largest proportion of patients actually fell in the intermediate-risk group. And they then took the intermediate risk patients, and they further sub-stratified them by the degree of RV function as measured by TAPSE and the degree of TR. And you see the low-risk, Group 1, had a TAPSE of greater than 19 millimeters, and minimal tricuspid regurgitation. And they were classified as an intermediate low-risk group. And actually, their 1-year outcomes were very similar to the low-risk group from the traditional risk model. Whereas in contrast, the patients that had low TAPSEs, less than 19, and significant tricuspid regurgitation, fell into this intermediate high-risk group. And their 1-year outcomes were very similar to patients that fell into the higher risk group by the traditional risk factors.

And this case kind of is an example of how to use the echo to sort out kind of functional limitations in a complex patient with multiple comorbidities. This patient has connective tissue disease ILD. She was admitted with heart failure and has pulmonary hypertension. You can see her functional limitations here by her WHO functional class and our 6-minute walk, very high, BNP, TAPSE is low at 15, has a moderate pericardial effusion. You can see the image on the left, she has significant RV enlargement and right atrial enlargement. And then this is the comparison after pulmonary hypertension therapy. You do see improvements here. Here 6-minute walk test is better, though she still remains somewhat limited with a functional class III symptoms. And given her limitations, she might have been put in kind of an intermediate-risk status by the pulmonary hypertension guidelines, or by the traditional risk factor models. But you can see here that her echo shows a normal TAPSE, pericardial effusion is now absent, and the RV size has shrunk down to normal. And so this patient looks, by echo, to be in a relatively low-risk standpoint from pulmonary hypertension. And you can likely ascribe her residual functional limitations to factors such as her lung disease or her joint pain, and not pulmonary hypertension.

So in summary here, the echo can be a very valuable tool in tandem with some of our other risk assessment platforms to really complement each other and trend patients throughout PH therapy.

That's it for this episode. Thank you, guys, for your time.

**Announcer:**
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