

## Suboptimal Heart Rate

When a patient referred for exercise stress myocardial perfusion imaging (MPI) does not achieve the target heart rate ( $\geq 85\%$  of the predicted maximal heart rate), the procedure can be inefficient. Importantly, suboptimal exercise levels can decrease the sensitivity of testing and lead to false-negative results.<sup>1,2</sup>

### SUBOPTIMAL HEART RATE AND LABORATORY INEFFICIENCY

The need to abort studies due to suboptimal exercise efforts is a major cause of nuclear cardiology laboratory inefficiency. Injecting a tracer at an inadequate exercise level and having to repeat the study with pharmacologic stress poses a lose-lose situation for both the patient and the medical staff, as shown in the table below.<sup>3</sup>

CLINICAL IMPACT OF SUBOPTIMAL EXERCISE ON MPI
Necessity for re-injection and re-imaging, usually on a separate day
Doubling the radiation exposure for patients
Scheduling disruptions for busy nuclear cardiology laboratories and patients
Delay in providing diagnostic information to physicians

### FALSE NEGATIVES

In exercise MPI, it is important to carefully ascertain that the patient has reached an ischemic endpoint or an adequate level of exercise. Because suboptimal exercise reduces sensitivity,<sup>1</sup> an incorrect diagnosis may result without additional diagnostic testing.

In patients with suboptimal exercise efforts, negative study results may be false negatives, prompting the need for a more definitive study—usually a second imaging study or cardiac catheterization. To avoid this situation, pharmacologic stress should be considered in patients known to have had suboptimal exercise efforts in past studies.<sup>1,3</sup> Pharmacologic stress results in consistent coronary vasodilation, thereby avoiding the problem of suboptimal studies and reduced sensitivity.<sup>4</sup>

### SPECIAL POPULATIONS

#### WOMEN AND TARGET HEART RATE

When compared with men of the same age, women are less likely to be able to achieve an adequate exercise heart rate.<sup>5</sup> Also, because women present with coronary artery disease 10 years later in life than men,<sup>6</sup> their ability to exercise may be different. Accordingly, the American Society of Nuclear Cardiology recommends that “women incapable of performing a minimum of 5 metabolic equivalents of exercise should be considered candidates for myocardial perfusion imaging with pharmacologic stress.”<sup>7</sup>



Comorbidities, including diabetes and obesity, may further compromise the utility of exercise testing in women because of both decreased exercise capacity and inability to reach target heart rate.<sup>8</sup>

#### PATIENTS WITH HYPERTENSION

Exercise testing may result in aborted studies in patients with systemic and pulmonary hypertension. In patients exercising while taking certain antihypertensive medications, the results may be nondiagnostic because of a blunted heart rate and reduced exercise duration. However, if medications are stopped before exercise testing, uncontrolled hypertension may result in a test aborted for safety reasons. In these situations, pharmacologic stress testing may be appropriate.<sup>3</sup>



## MINIMIZING ABORTED STUDIES

For some patients, it may be unclear what level of exercise can be performed. It is important to recognize that certain patient types may be less likely to achieve maximal exercise, as shown in the table below.

COMMON PATIENT TYPES LESS LIKELY TO ACHIEVE MAXIMAL EXERCISE
Women
Patients with diabetes
Obese patients
African American women
Patients with hypertension

When a patient's ability to exercise is unclear, it may be possible to try exercise first. However, if the exercise duration or heart rate response is inadequate, the radiotracer should not be injected and the protocol should be changed to pharmacologic stress.<sup>3</sup> Technicians must be willing to not inject the radiotracer in patients who fail to reach maximal exercise levels.<sup>3</sup> This will help avoid aborted studies and also help avoid the reduced sensitivity associated with suboptimal exercise efforts.

In order to switch from exercise to pharmacologic stress testing if the need arises, prepare all patients—including those scheduled for dynamic exercise—as if they were going to have a pharmacologic stress test. Verify that all patients have abstained from caffeine and other methylxanthines for at least 24 hours prior to testing. This way, the study can be done on the same day without wasting a radiopharmaceutical dose or the scheduled camera and technologist's time.

## CONCLUSION

Suboptimal exercise can have a negative impact on MPI results, decreasing the sensitivity of testing and leading to false-negative results. By preparing all stress MPI patients as if they were going to receive pharmacologic stress, and by not injecting radiotracer in patients with suboptimal exercise levels, laboratory efficiency and patient management can be improved.

### References

1. Iskandrian AS, Heo J, Kong B, Lyons E. Effect of exercise level on the ability of thallium-201 tomographic imaging in detecting coronary artery disease: analysis of 461 patients. *J Am Coll Cardiol.* 1989;14:1477-1486. 2. Iskandrian AS, Hakki A-H. Thallium-201 myocardial scintigraphy. *Am Heart J.* 1985;109:113-129. 3. Cerqueira MD. Pharmacologic stress versus maximal-exercise stress for perfusion imaging: which, when, and why? *J Nucl Cardiol.* 1996;3:S10-S14. 4. Cerqueira MD, Verani MS, Schwaiger M, Heo J, Iskandrian AS. Safety profile of adenosine stress perfusion imaging: results from the Adenoscan Multicenter Trial Registry. *J Am Coll Cardiol.* 1994;23:384-389. 5. Isaac D, Walling A. Clinical evaluation of women with ischemic heart disease: diagnosis and noninvasive testing. *Can J Cardiol.* 2001;17(suppl D):38D-48D. 6. Wenger NK. Coronary heart disease in women:



**Because suboptimal exercise reduces sensitivity,<sup>1</sup> an incorrect diagnosis may result without additional diagnostic testing.**

evolving knowledge in dramatically changing clinical care. In: Julian DG, Wenger NK, eds. *Women and Heart Disease*. London: Martin Dunitz; 1997:21-38. 7. Mieres JH, Shaw LJ, Hendel RC, et al. A report of the American Society of Nuclear Cardiology Task Force on Women and Heart Disease (Writing Group on Perfusion Imaging in Women). *J Nucl Cardiol.* 2003;10:95-101. 8. Consensus development conference on the diagnosis of coronary heart disease in people with diabetes: 10-11 February 1998, Miami, Fla. American Diabetes Association. *Diabetes Care.* 1998;21:1551-1559.

For interactive *Tech Tips* and more, visit [pharmstresstech.com](http://pharmstresstech.com).

Provided as an educational service by **Astellas Pharma US, Inc.**

COMMITTED TO CARDIOLOGY<sup>®</sup>