SHAPE Testing

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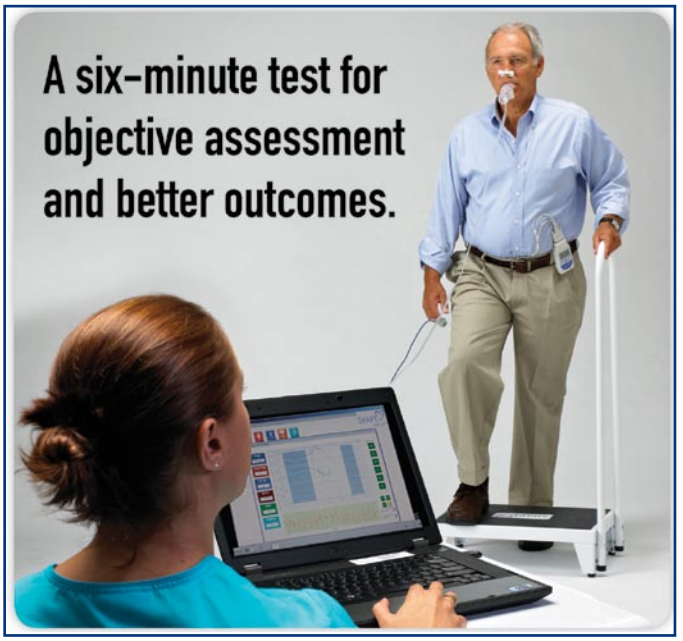
SHAPE testing is a promising technology that simplifies cardiopulmonary exercise testing to allow better and easier evaluation of patients with cardiopulmonary diseases.

SHAPE: This stands for Sub-maximal Heart and Pulmonary Evaluation, and it is a cardiopulmonary exercise test (CPX) now available at Florida Hospital (Orlando and Winter Park Campuses), as well as in the Florida Hospital Advanced Heart Transplant and Advanced Lung Disease Clinic. SHAPE is also available at The Central Florida Pulmonary Group (Altamonte Springs, Downtown Orlando, and East Orlando offices. This test (like other CPX) assesses oxygen consumption and carbon dioxide output. In turn, this reflects the performance capabilities of the heart, lung, peripheral vasculature and blood to sustain oxygen delivery and carbon dioxide removal which are so critical for our daily activities and function. The advantage of SHAPE is that the variables are obtained not only at rest, but also during exercise. This provides superior evaluation when compared with assessments made at rest which have been the traditional modalities utilized in patients with cardiopulmonary problems. For example, when a problem is present that would manifest as inadequate functional capacity, CPX can assist in identifying which parts of the physiologic system are responsible for that limitation. While CPX is a technology which has been around for many years, it continues to be the optimal test to evaluate patients with cardiopulmonary problems during exercise. Unfortunately, it has been underutilized because it requires sophisticated equipment and highly trained personnel to not only perform the tests, but also interpret the data. In addition, CPX requires maximal exercise. In constrast, with SHAPE, the complexities and technical challenges of performing cardiopulmonary exercise testing are overcome. The SHAPE system makes it easy to perform the tests and collect the data. Furthermore, it uses a small portable machine that can be kept at the office. Most importantly it only requires submaximal exercise (it is easier for patients to perform and closely mimics their daily activities).

Anyone can experience dyspnea when they engage in vigorous physical activity, even in the presence of a normal cardiovascular and respiratory system. The degree of dyspnea is closely related not only to the effort and workload, but also to the degree of fitness; cardiovascular fitness is determined by the ability of the heart to increase cardiac output and by the ability of the peripheral muscles to utilize oxygen efficiently. It is common for patients with chronic cardiopulmonary disease to assume a sedentary lifestyle in an effort to avoid discomfort. However, this causes the individual to become progressively deconditioned and ultimately they become limited more by the deconditioning rather than the underlying disease. Therefore, evaluation with SHAPE can determine if the patient is actually limited by deconditioning rather than cardiopulmonary dysfunction. If an individual has a normal cardiopulmonary system, the only dyspnea they are likely to experience is that which occurs with heavy exercise. Therefore, it is difficult to assess a patient by only using resting pulmonary and cardiac testing since these cannot reliably predict exercise performance. In contrast, during submaximal exercise, there is the opportunity to evaluate the interaction between the heart and lung and better correlate overall health status and detect any problem that might be present. SHAPE system (like any other CPX) helps to determine respiratory efficiency by measuring gas exchange at rest and exercise. In normal subjects, there is an increment of cardiac output and lung perfusion (Q) with an associated increase of minute ventilation (VE) in order to maintain stable arterial carbon dioxide levels. Lung units that match ventilation with



perfusion (V/Q) optimize gas exchange. However, the lung usually does not have completely ideal properties and the actual VE includes ventilation to non-gas exchange conducting airways, and to alveoli that may not be ideally perfused. This mismatch is known as dead space ventilation (VD). A valuable estimate of the degree of mismatching of ventilation to perfusion is the dead space/tidal volume ratio (VD/VT) which is lowest when ventilation relative to perfusion is uniform, i.e., during moderate exercise. In patients with an airway disorder, the VD/VT is increased primarily because of non-uniform ventilation of perfused lung units. In patients with heart failure and pulmonary vascular diseases, VD/VT is increased primarily because of impaired perfusion to ventilated lung. Because physiologic factors usually override psychological factors during moderate exercise, moderate exercise is the ideal time to assess the VD/VT and the efficiency of ventilation in removing carbon dioxide. When VD/VT is increased, VE is typically inordinately high for the work rate performed. Therefore, high minute ventilation (VE) at a given exercise level and respective CO2 production(high VE/VCO2) is indicative of a high VD/VT (as long as hyperventilation has been excluded). In addition, the expired CO2 dynamics during exercise will reflect overall lung perfusion. For example, an inadequate increment of expired CO2 with exercise may be found in patients with underlying pulmonary hypertension.

In summary, SHAPE testing brings the opportunity to easily incorporate CPX in clinical practice and allows clinicians to utilize physiological parameters like VE/VCO2, oxygen uptake efficiency, and change in Pet CO2 — all of which are known to have strong correlation with performance status and survival in patients with cardiopulmonary disease. More importantly, SHAPE can be used to evaluate physiological improvement or worsening in ventilation/perfusion mismatching which can help in the overall medical optimization of these complex patients and can significantly impact patient management in a positive way.

Dr. Andres Pelaez, MD received a fellowship in interventional bronoschopy and lung transplant at the University of Texas Health Science Center-San Antonio (UTHSCSA). He also received a fellowship in pulmonary disease and critical care medicine at Emory University School of Medicine. He did his residency in internal medicine at the University of Texas Health Science-San Antonio (UTHSCSA) and went to medical school at the Centro de Estudios de la Salud in Medellin, Colombia, South America. Dr. Pelaez specializes in lung transplantation and the treatment of complex airway conditions.

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