Respiratory muscle weakness can occur in neuromuscular diseases as well as in pulmonary disease. For example, in chronic obstructive pulmonary disease, patients' muscles may become weakened from hyperinflation, which causes the diaphragm to function at a poor mechanical advantage, or in patients on steroids that can result in myopathies. Pulmonary function tests are used to determine diagnosis, prognosis, and, when available, the effect of treatment. While vital capacity decreases in muscle weakness, and hypercapnia can be present, these measurements are both non-specific and occur after muscle strength is decreased by as much as half. In fact, we need to be able to differentiate limitations caused by parenchymal and airway diseases from those attributable to the respiratory muscle weakness.

While there are other specific tests to measure respiratory muscle strength, determination of maximal inspiratory pressure (MIP) and maximal expiratory pressure (MEP) can be performed routinely in a pulmonary function laboratory, requiring only the minimum of equipment. These tests measure the overall muscle function and are carried out while the mouthpiece is closed so that the patient cannot inhale or exhale; lung volumes remain unchanged, so the performance of the muscles can be separated from the performance of the lung. A small leak prevents pressure from being generated by cheek muscles.

However, pulmonary function tests must be standardized to be reliable, and any test result is only as good as the available reference values and lower limit of normal (LLN) values. Reference equations for MIP and MEP have been limited, and their use hampered by the variation in the techniques used.

The 2002 American Thoracic Society/European Respiratory Society (ATS/ERS) Statement on Respiratory Muscle Testing\(^1\) has standardized the measurement, and lists reference normal ranges for the 2 types of mouthpieces generally used, straight tube and flanged, from several authors. For clinical use they recommend flanged mouthpieces even when flanged mouthpieces are used, although Black and Hyatt used straight tubes.

Two papers in this issue of Respiratory Care aim at helping pulmonary function laboratories further standardize their procedures and update their predictive equations, while approaching the problem in totally different ways.

The article by Evans and Whitelaw\(^4\) very ambitiously reviews the literature, adds to the standardization of the methodology recommended by the American Thoracic Society,\(^1\) and derives reference equations with LLN values by what the authors call “amalgamated results.” In this amalgamation they use only studies with flanged mouthpieces, because of the ATS recommendation.

The reference equations by Evans and Whitelaw\(^4\) are for MIP and MEP and the LLN values for adult males and females as a simple function of age, up to “approximately” age 70. Other independent variables are not included in each equation, because the contributions of these other variables, such as height and body mass index, are smaller than the variation of the measurement. They also found no consistent differences with race, and whatever differences there may be are well within the variation of the measurement. The equations are listed in Table 2 of their paper and can also be found in the abstract. Nice graphical displays in their Figures 2 through 5 help us see how the derived equations and LLN values compare with the studies used to derive them.

However, because the equations are a composite and not measured directly, and because of the limitations inherent in the measurements themselves, there are some important caveats that the authors point out. First of all, the pressures are generated by muscles that are used for more than just respiration; thus, strength could decrease below the LLN, and normal breathing at rest could still be possible. Alternatively, a value below the LLN doesn’t necessarily mean an abnormality, as there is substantial patient effort required, and significant variations in results among personnel performing the test have been reported. These tests, even more so than others, must be used in conjunction with the clinical picture, and are best when a previous result is used for comparison. Finally, the results may not be linear as the patients get older;
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References