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Editorial

Bedside Pulmonary Function Tests: An Easy and Simple Pre-Operative Tool

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INTRODUCTION

Bed-side pulmonary function tests (PFTs) are valuable tools for assessing the cardio-pulmonary status and ventilatory capacity of patients in a quick and convenient manner. PFTs are commonly used to evaluate signs and symptoms like breathlessness, chronic cough, and exertional dyspnea in patients with asthma and chronic obstructive pulmonary disease (COPD) along with other restrictive and obstructive lung diseases. These tests will help to assess the severity of disease and provide an approximate measure of the patient's respiratory function and assist an anesthesiologist in determining their eligibility for specific medical procedures or surgeries.

The Breath-holding test, also called the Saberazes test,[1] is one of these tests. The Saberazes Breath-holding test is a simple test that measures the response of the body to the oxygen-carbon dioxide balance in the alveolar air, blood, and tissues under all conditions of health and disease.[2] To perform the test, the patient is asked to take a full breath but not too deep and hold it for as long as possible. A normal result is greater than 25 seconds, while a result of less than 15 seconds indicates poor cardio-pulmonary reserve (CPR) and may be a contraindication for elective surgery.[3] A result between 15-25 indicates limited CPR. Another similar test is the Single breath count test,[4] which measures how many counts a person can say after holding their breath. Normal is 30-40 counts; It is widely used to assess respiratory muscle strength at the bedside, and it is indirectly linked to vital capacity (Table 1).

Table 1. *Saberazes Breath Holding Time and Inferences*

Saberazes Breath Holding Test	
Breath Holding Time	**Vital Capacity**
25-30 Seconds	3500 ml
20-25 Seconds	3000 ml
15-20 Seconds	2500 ml
10-15 Seconds	2000 ml
5-10 Seconds	1500 ml

Snider's match-blowing test[5] is an alternative method for determining expiratory capacity and maximum breathing capacity (MBC). In this test, the patient is instructed to inhale maximally and then exhale rapidly, attempting to extinguish a burning match held 6 inches (15 cms) from their mouth without using their lips. Having an MBC above 60 liters per minute and an forced expiratory volume in one second (FEV1) above 1.60 liters allows patients to safely extinguish a match, indicating that they can undergo thoracic or non-thoracic surgery without any problems. However, if the patient is unable to extinguish the match and has an MBC of less than 60 L/min and a FEV1 of less than 1.6 liters, this indicates diminished respiratory function. As an extra measure, you can do the modified Snider's test, which is as follows: MBC>40 L/min at 3 inches; MBC>60 L/min at 6 inches; MBC>150 L/min at 9 inches (Figures 1 and 2).

Figure 1. *Match Blowing Test*

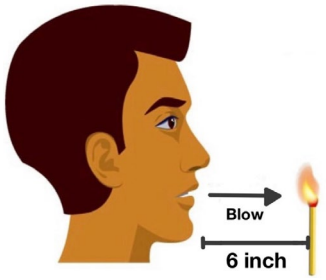


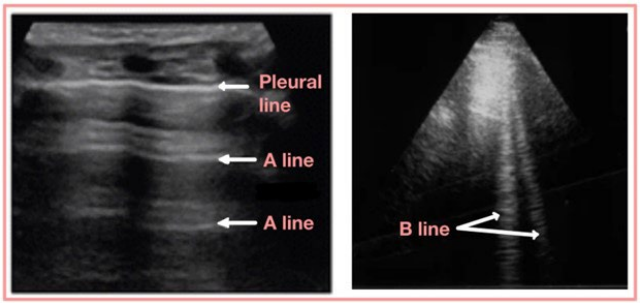
Figure 2. *De Bono's Whistle*

De Bono's Whistle Blowing Test[6] is a test that measures peak expiratory flow rate (PEFR). This test was invented by Edward de Bono in 1963 as a simple, cheap, portable, and adjustable instrument for measuring the volume of air breathed out by the lungs and for use in screening procedures. To perform the test, the patient blows down a wide bore tube, at the end of which is a whistle. On the side of the tube, there is a hole with an adjustable knob. As the patient blows down the tube, the whistle sounds only when the rate of airflow exceeds a certain value. The side leak hole gradually increases until the intensity of the whistle disappears.[7] The last position when the whistle can be appreciated is read off the scale and taken as the PEFR. The test measures their fastest breath speed, which can be as high as 300 liters per minute.

The Greene and Berowitz cough test assesses the strength and effectiveness of the respiratory muscles. The patient is instructed to take a deep breath and cough. An effective cough would necessitate a vital capacity (VC) equal to three times the tidal volume (TV).[8] If the patient is unable to do so, an Forced Vital Capacity (FVC)<20 mL/Kg, FEV1 < 15 mL/Kg, and PEFR<200 L/min can be considered.

The Tracheal auscultation test is another bedside test done during a forced expiration to measure forced expiration time. The patient is usually instructed to take deep breaths while the provider listens for any abnormal sounds such as wheezing, crackles, stridor, or diminished breath sounds. These sounds may indicate a number of conditions affecting the trachea or larger airways, such as infections, obstructions, or airway constriction. This test has a normal value of 3 to 5 seconds, while a duration of 6 seconds is indicative of obstructive airway disease. Auscultation over the trachea during forced expiration helps identify potential airway obstructions. Normally the sounds are heard for 3-5 seconds. If < 3 seconds, then a restrictive type of disease may be present, and > 6 seconds, then an obstructive lung disease may be present. Healthcare professionals can detect abnormalities such as prolonged exhalations, wheezing sounds, or less airflow by carefully listening to a patient's breathing.[9] These findings could suggest that someone has obstructive airway disease and provide guidance on further tests or treatment. It is a non-invasive and relatively simple procedure that can provide valuable information to aid in the diagnosis and management of respiratory conditions (Figure 3).

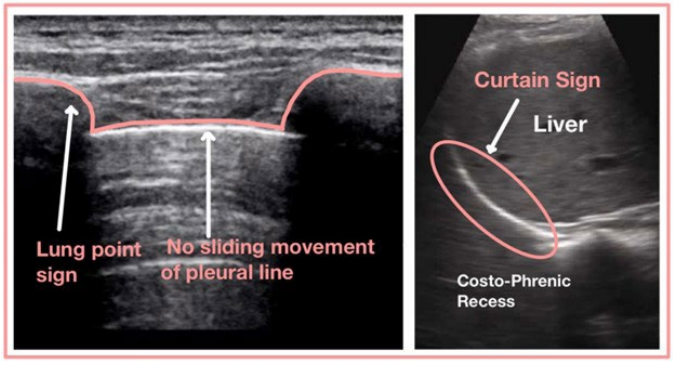
Figure 3. *Left-side Image Showing Lung A-line and Right-side Image Shows the Lung B-line*



Lung ultrasound is a non-invasive diagnostic tool that can be used at the bedside to assess pulmonary function.[10] It is utilized to detect lung sliding, pulse, A- and B-lines, B1 and B2 patterns, curtain signs, and additional lung ultrasound findings. The movement of the pleural line during respiration is called lung sliding. It indicates healthy lung function. B-lines are associated with interstitial edema and are classified according to seven criteria.[11] Multiple well-spaced B-lines with preserved lung sliding constitute the B1 pattern. Multiple coalescent B-lines with preserved lung sliding constitute the B2 pattern. A-lines are horizontal artifacts that arise from the pleural line at regular intervals equal to the skin-pleural interface distance, indicating physiologic air (but also free air) (Figure 4).

The lung point sign is a diagnostic sign for pneumothorax and is defined as the point where lung sliding is present adjacent to

Figure 4. *Left-side Image of Pneumothorax, Showing Lung Point with Absence of Sliding Movement of Pleural Line and Right-Side Lung Curtain Sign Showing Overlaps Part of the Liver at Costo-Phrenic Recess by Aerated Lung*



an area where lung sliding is absent. Pneumothorax separates the visceral and parietal pleural surfaces and the point at which these surfaces meet is considered as a lung point. The curtain sign refers to the normal ultrasound characteristics of the lung bases in fully aerated lungs. This is due to the fact that the air in the costophrenic recess will create a hyperechoic "air curtain" over the recess, obscuring the outline of the lateral diaphragm. Following the movements of the lungs during respiration, the "air curtain" will also move in the craniocaudal direction. Lung pathology (pleural effusion) should be suspected when the lateral diaphragm is completely visible or there is a loss of normal movement of the air curtain.

The Stair test and Walk test are practical methods for determining exercise tolerance and evaluating respiratory function. The Stair test consists of climbing three flights of stairs, with each flight consisting of twenty 15 cm tall steps, for a total of sixty steps.[12] This test checks how well the patient can handle physical activity. Likewise, the Walk test, or Richter test, evaluates the distance a patient can walk briskly within a span of 6-minutes. It is also known as the 6-minute walk test (6 MWT),[13] and it is a simple, practical test that measures a person's ability to walk for six minutes on a hard, flat surface. The objective is to walk as far as possible within six minutes. The test is commonly conducted on individuals with chronic respiratory disease, heart failure, and other chronic conditions to evaluate their functional exercise capacity. It can also be used to monitor the response to treatment and evaluate the effectiveness of rehabilitation programs. A distance of 600 meters in 6-minutes is considered a normal result. The Walk test and Stair test are functional assessments that evaluate exercise tolerance and overall respiratory function. These assessments give information about the patient's capacity for physical activity, and we can use them to monitor the patient's progress throughout their recovery or to determine whether they are capable of handling particular tasks.

The Wright spirometer is an instrument used at the bedside to measure the patient's TV and minute volume (MV).[14] The instrument is light, compact, and portable, and it can be connected to an endotracheal tube or a face mask. Additionally, the assessment is simple and quick. The problem with this device is that it overreads at high flow rates and underreads at low flow rates. The patient is asked to breathe through the instrument for one minute while seated, and the respiratory rate is recorded. The minute ventilation is directly recorded and displayed on the instrument. By subtracting the MV from the respiratory rate, the TV can be calculated. A measurement that is reasonably accurate can be made between the range of 3.7 and 20 L (10%). It is a very helpful tool for PFT at the bedside and in the intensive care unit (ICU) when weaning patients off the ventilator (Figure 5).

The Mini-Wright Peak Flow Meter determines the openness of the airway by defining the amount of air that can be blown out of the lungs in a rapid burst. This peak flow meter, which is portable and lightweight, is considered the "Gold Standard" for managing asthma and it is primarily used to measure peak flow. Like most pulmonary function tests, the peak flowmeter requires patient cooperation. The normal value for males is 450-700 L/min, that for females is 300-500 L/min (Figure 6).

Figure 5. *Wright's Spirometer*

Figure 6. *Mini Wright's Peak Flowmeter*

In conclusion, bedside pulmonary function tests can be useful in pre-operative anesthesia assessment. These tests provide healthcare providers with valuable information about a patient's breathing ability, helping them make decisions about the patient's care. By carrying out these tests at the patient's bedside, anesthesiologists can assess a patient's capacity to tolerate anesthesia for the intended procedure quickly and non-invasively, minimize the risks of anesthesia and surgery, and get the patient ready for the procedure. They are speedy, not intrusive, and can beconducted in many different medical locations. Although these tests provide useful information, they are not a substitute for comprehensive pulmonary function tests performed in a specialized laboratory.

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CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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