...irometric testing of pulmonary ...unction

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Spirometry is the most common test of pulmonary function carried out in the office setting. Although it does not provide a specific diagnosis, it does indicate whether lung function is normal or abnormal and whether an abnormality is obstructive, restrictive, or both. As a valuable tool in primary care practice, it helps you to evaluate such pulmonary signs and symptoms as cough, wheezing, and dyspnea; to gauge the severity of airflow obstruction in obstructive lung disease; to monitor the response to bronchodilator therapy; to confirm the presence of upper-airway obstruction; and to assess the status of high-risk patients who are about to undergo a thoracic or upper abdominal surgical procedure.

Most office spirometers are computerized and easy to use. Some instruments measure the volume of gas expired over time and calculate flow from this value, whereas others are equipped with a pneumotachograph and measure flow, determining the volume of expired gas by integration of the flow signal. Most spirometers provide a graphic display of the volume-time and flow-volume curves.

The technician who performs the test describes the process to the patient, demonstrates the respiratory maneuvers that are necessary, and asks the patient to perform these maneuvers at a maximal level. Administration of pulmonary function testing is described in detail on page 51 (Performing the test).

Ensuring Accuracy

For the results to be valid, you must follow the established criteria for spirometric testing, which were provided by the American Lung Association.[1] Careful attention must be paid to both the technician's and the patient's performance of the test. Pulmonary function testing may yield inaccurate information if the patient is not seated upright or makes a less-than-maximal effort, if the measure of forced vital capacity (FVC) cannot be reproduced within 5% on at least two separate trials, or if the test is terminated before the minimum exhalation time is met. For example, a patient with severe air-flow obstruction may have a low flow rate and prolonged expiratory effort; if the spirometer is programmed to identify the end of the test too early, the FVC will be falsely lowered.

Interpreting the Results

In addition to an examination of the flow-volume curve, as described on page 52 of the illustrated guide (Flow-volume curve), interpretation of the basic spirometric findings includes determination of the ratio of forced expiratory volume in 1 second (FEV_1) to FVC. A low value indicates an obstructive defect, as shown on page 53 (Large-airways obstruction). The obstruction is characterized as mild if the FEV_1/FVC is 61% to 69%, moderate if it is 45% to 60%, and severe if it is less than 45%.

If the ratio is normal or high, turn your attention to the FVC. If it is low, particularly if the FEV_1 is lowered proportionately, the patient may have a restrictive ventilatory defect. In this case, measurement of the reduction in lung volume is recommended.

To determine the absolute volume of gas in the lung, the physician must know the residual volume. This is usually derived by measuring the functional residual capacity and subtracting it from the expiratory reserve volume. The functional residual volume can be measured by using a dilution principle or a body plethysmograph to determine thoracic gas volume. □

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and nutritional disturbances still can occur with these procedures. Also, few data regarding long-term consequences are available.

A few other techniques have been popularized but deserve only brief mention. Fat excision, jaw wiring, waist banding, and intragastric balloons have all been reported to induce weight loss. These procedures have been shown to be successful only in the short term and some have had major complications. Few bariatric surgeons perform them. Some success has been reported with lesser gastric procedures such as gastric restriction with adjustable Silastic bands. These procedures apparently have fewer operative risks and a shorter recovery period.

Laparoscopic bariatric surgery. Recent interest in these procedures stems from the ability to perform the surgery laparoscopically.[20] The assumption is that the perioperative benefits of laparoscopic surgery (ie, less pain, shorter hospitalization, more rapid convalescence) would be particularly beneficial in this patient population. Early results from Europe are encouraging. However, repeat surgeries are necessary in up to 20% of cases. The laparoscopic adjustable gastric band is now being evaluated in a multicenter trial in the United States, but it has not yet been approved for use.

SURGICAL OUTCOMES

Several reports on the usefulness of the gastric bypass have been criticized for lacking consistency or for limited patient follow-up. The better studies have shown good results, though: Weight loss is usually reported to be 60% of excess weight within the first 2 years and generally remains stable over time.[19,21] Recently, Pories and colleagues reported that patients have sustained weight loss for 14 years after gastric bypass (49% of excess weight).[19]

Despite these seemingly good results, 20% to 25% of patients do not respond adequately or regain the lost weight. Although some postoperative failures can be traced to technical errors, most can be attributed to dietary noncompliance. In these cases, patients chronically overeat calorie-dense foods, candies, or other sweets. Over time this behavior can result in pouch dilatation or staple-line disruption. Patients often present with chronic vomiting, increasing appetite, increasing meal capacity, and gradual weight gain.

CONCLUSION

Obesity is presently an incurable disease. Since its biologic basis remains unknown, specific therapy is still not available. The cost of obesity and its comorbidities mandates concerted efforts to find effective treatments and maybe even a cure. For now, treatment should be individualized according to the patient's degree of obesity, comorbidities, and behavior profile. Mildly obese patients may respond to dietary, behavioral, and/or pharmacologic interventions, whereas severely obese patients may do better with surgery. A multidisciplinary approach is usually required and can result in favorable and durable outcomes. □

Authors' disclosure statement

The authors have indicated no significant financial interest in or other relationship with the manufacturer of any commercial product discussed in this article.

Acknowledgment

The contents of this article do not necessarily reflect the views or policies of the US Department of Agriculture, nor does mention of trade names, commercial products, or organizations imply endorsement by the US government.

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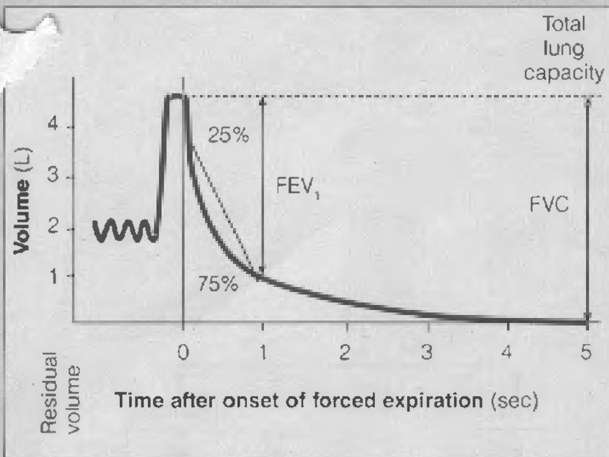
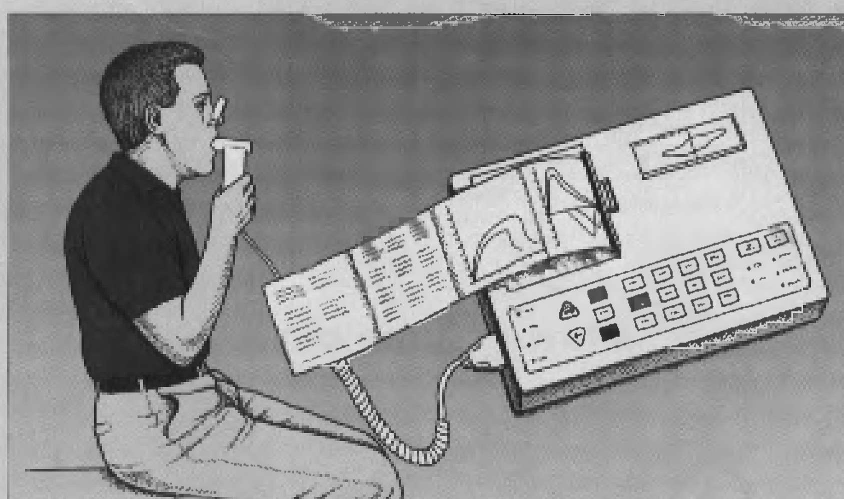
Spirometry



Spirometry measures three components of lung function: FVC, FEV_1, and mean forced expiratory flow during the middle 50% of the forced expiratory maneuver ($FEF_{25\%-75\%}$). The FVC represents the volume of air that can be exhaled forcibly after the lung is filled to its total capacity. The FEV_1 represents the volume of gas forcibly exhaled in the first second of expiration after filling the lung to total capacity; normally, more than 75% of the total volume of gas can be exhaled in this time. The $FEF_{25\%-75\%}$ is determined by the slope of a line drawn between the points representing 25% and 75% of FVC on the volume-time curve. When this value is lower than normal, which is >4.7 L/sec in men, it indicates the presence of air-flow obstruction; this tends to be a distal obstruction—that is, an obstruction of the small airways—since the $FEF_{25\%-75\%}$ reflects air flow during an effort-independent portion of the curve.

Performing the test

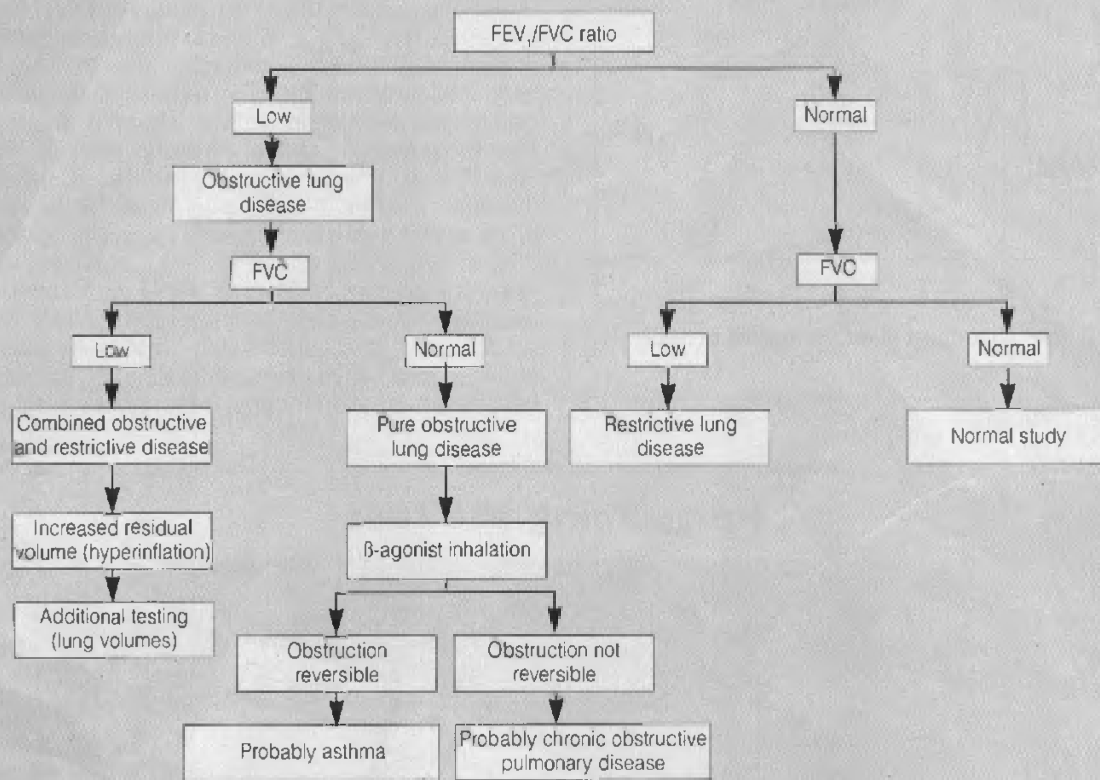


The patient is seated upright in a chair and breathes through a mouthpiece connected to the spirometer. Noseclips are usually placed to prevent air leaking through the nose. The patient first breathes through the spirometer circuit for 1 or 2 minutes to become familiar with the apparatus. The technician then instructs the patient to inhale as deeply and quickly as possible to total lung capacity and then to exhale quickly and forcibly for at least 6 seconds until no further air can be expelled. Then normal breathing is resumed for 1 or 2 minutes. This procedure is repeated until the examiner has obtained and accepted three sets of values that are within 5% of each other, recording the highest value.

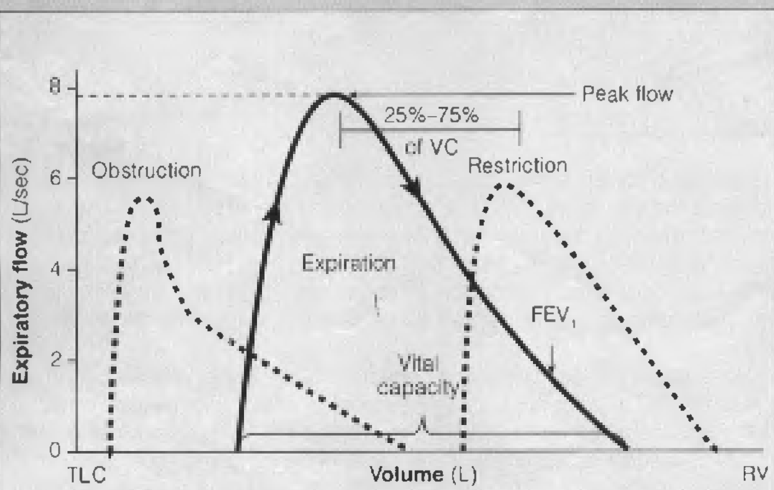
In some situations, it may be useful to assess a patient's response to a bronchodilator. For example, determining the potential effectiveness of such therapy is crucial in patients with airways obstruction. The patient must abstain from bronchodilator use for at least 24 hours before the assessment is carried out. After baseline spirometry is performed, two inhalations of a bronchodilator such as albuterol, metaproterenol, or ipratropium bromide are administered by metered-dose inhaler. After approximately 10 minutes, spirometic testing is repeated. If FEV_1 or FVC increases by at least 15% or $FEF_{25\%-75\%}$ increases by at least 30% after administration of the bronchodilator, the result is reported as positive for bronchodilator responsiveness.

continued

Interpretation of spirometry



Flow-volume curve

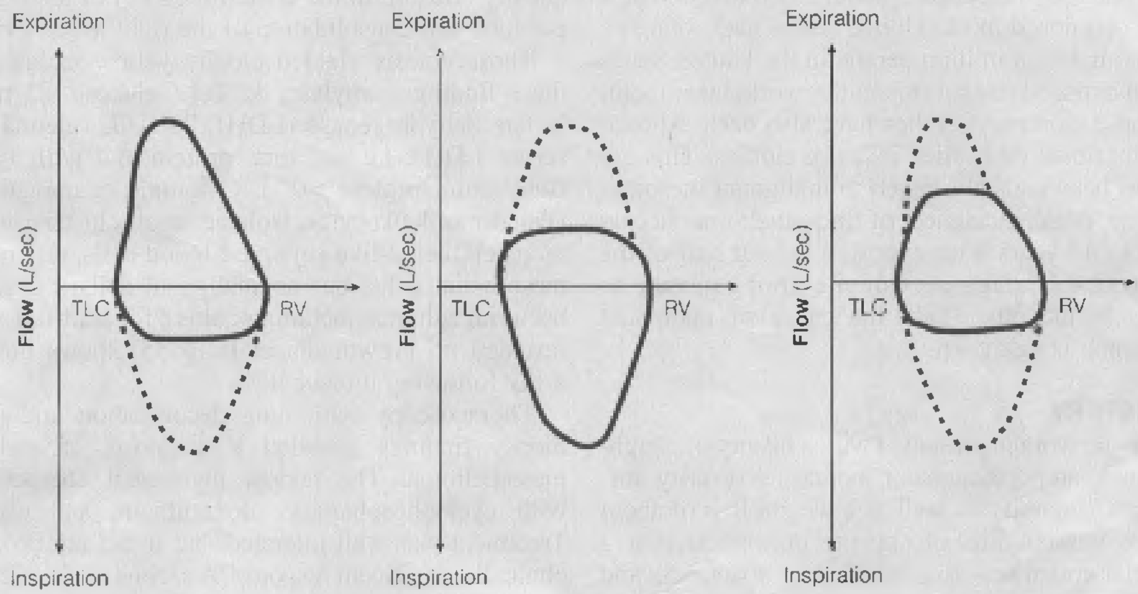


VC = vital capacity; TLC = total capacity; RV = residual volume

Interpretation of spirometric findings begins with examination of the flow-volume curve. In obstructive lung disease, the flow-volume curve reveals reduced expiratory flow. The curve shows a leftward displacement from the normal position because of an increase in lung volume secondary to air trapping. In restrictive lung diseases, the flow-volume curve is shifted to the right, indicating the hallmark reduction in lung volume, whereas air flow is unaffected.

Large-airways obstruction

Examination of the flow-volume curve is essential to determining the presence of large-airways obstruction. Three categories of abnormal flow-volume curves indicate obstruction of the large airways.[2]



Variable extrathoracic obstruction (vocal cord paralysis): On inspiration, atmospheric pressure exceeds intraluminal pressure, and inward collapse of the airways causes obstruction. The inspiratory portion of the curve is truncated. On expiration, however, intraluminal pressure is greater than atmospheric pressure and the airways remain patent. Thus, the expiratory limb of the flow-volume curve is preserved.

Variable intrathoracic obstruction (tracheomalacia): On inspiration, the intraluminal pressure is greater than the pleural pressure, and the airways remain patent. On expiration, however, the intraluminal pressure at the area of abnormality becomes less than the pleural pressure, and the airways collapse, causing obstruction. The contour of the curve is normal during inspiration, but the expiratory limb of the curve is truncated, representing a reduction in airflow because of obstruction.

Fixed intrathoracic or extrathoracic obstruction (tracheal stenosis, foreign body, or tumor): The intraluminal pressure remains constant under both pleural and atmospheric pressures. Thus, the flow-volume curve reflects a reduction in flow during both inspiration and expiration.

TLC = total capacity; RV = residual volume

Based on Kryger M, Bode F, Antic R, et al: Diagnosis of obstruction of upper and central airways. *Am J Med* 61:85, 1976.

Malignant mesothelioma

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The mesothelium lines the pleural cavities. Mesothelial neoplasms may be localized or diffuse and benign or malignant. According to the National Cancer Institute, the incidence of malignant mesothelioma is 0.9 cases per 100,000 people;[1] about 2,000 to 3,000 new cases are diagnosed in the United States each year.

Approximately 8 million people in the United States have been exposed to asbestos in the workplace; members of these workers' families have also been exposed to asbestos fibers embedded in work clothes. This exposure has been causally linked to malignant mesothelioma. The peak incidence of mesothelioma occurs about 35 to 45 years after exposure. About half of the patients with this diagnosis can cite prior exposure to asbestos.[2] In the other half, the cause of malignant mesothelioma is unknown.

CASE HISTORY

A 60-year-old woman presented with a history of coughing, dyspnea, and orthopnea of increasing severity during the past 7 months, as well as a weight loss of about 25 pounds without loss of appetite during the past 2 months. Her cough was accompanied by hoarseness and profuse "sinus drainage." Her orthopnea was partially relieved by lying in the left lateral decubitus position. There was no history of fever, night sweats, cigarette smoking, hemoptysis, chest pain, or previous pulmonary disease. The patient reported possible asbestos exposure, as she had worked in the military. Two weeks prior to hospital admission, she complained of flulike symptoms and was treated with an antibiotic without improvement.

On physical examination the patient was in respiratory distress. The left lung was resonant to percussion with normal breath sounds on auscultation. The right lung was dull to percussion with decreased breath sounds over the middle and lower lobes and vocal fremitus on auscultation. Cardiac auscultation revealed a loud S_2 in the second and third intercostal spaces in the left parasternal line. There was no clubbing or cyanosis or other remarkable findings except for thrombocytosis (platelet count, 462,000 cells/mm^3).

A chest x-ray revealed a large right pleural effusion and widened suprahilar mediastinum with a right upper lobe mass (Panel A, p 55). A computed tomography (CT) scan of the chest revealed a loculated, relatively high-density effusion in the posterior aspect of the right upper lobe and consolidation of the right lower lobe.

Thoracentesis yielded cloudy yellow exudate with these findings: amylase, 32 U/L; glucose, 83 mg/dL; lactate dehydrogenase (LDH), 78 IU/L (pleural fluid/serum LDH >1); and total protein, 6.4 g/dL (pleural fluid/serum protein >0.7). Cytologic examination revealed rare leukocytes, isolated small clusters of squamous epithelial-like cells, red blood cells, and reactive mesothelial cells, but no malignant cells. Fungal and bacterial cultures, including culture for acid-fast bacilli, revealed no growth. Panel B (p 55) shows the chest x-ray following thoracentesis.

Thoracoscopy with lung decortication and pleural biopsy findings revealed a diagnosis of malignant mesothelioma. The patient underwent chemotherapy with cyclophosphamide, doxorubicin, and cisplatin. Treatment was well tolerated, but it did not produce a clinically significant response. A second cycle of chemotherapy was scheduled.

DISCUSSION

Histology. There are three major histologic types of diffuse mesothelioma: fibrous or sarcomatous; epithelial; and mixed. The epithelial variant is the most common, but serial sectioning of the tumor frequently reveals it to be of mixed type.[3] Diffuse mesothelioma may be difficult to differentiate histologically from metastatic adenocarcinoma to the pleura, either from the lung or from another organ. This is because of the tubulopapillary pattern of the epithelial type of malignant mesothelioma. Various laboratory techniques can help establish the diagnosis. It is important to notify the pathologist if you suspect a diagnosis of mesothelioma.

Disease progression. Mesothelioma begins as discrete plaques and nodules that coalesce to produce a sheet-like neoplasm. Tumor growth usually begins in the

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