B. 10 Clinical pulmonary function tests

a. Distinguish between obstructive and restrictive lung disorders using the family of curves measuring forced expiratory volume, peak expiratory flow rate and vital capacity.

    The forced expiratory volume-time and flow-volume curves are useful in distinguishing between lung disorders. The volume-time curve which is obtained from a spirometer shows forced vital capacity (FVC) and allows reading of forced expiratory volume in 1 second (FEV₁).

    FVC is a good measure of the severity of restrictive lung disease. The expected normal value can be calculated from height, sex and age and a result less than 70% of predicted is indicative of restrictive lung disease. In isolated restrictive lung disease, the FEV₁/FVC is normal or increased.

    The ratio of FEV₁ to FVC is a good measure of obstructive airway disease. A value of less than 0.7 (70%) is indicative of airway obstruction limiting expiratory flow abnormally. This is independent of FVC. FVC is commonly reduced in patients with obstructive disease as many have a concomitant restrictive deficit as well.

    Peak expiratory flow rate (PEFR) can be read from the flow-volume curve or measured separately with a Wright peak flow meter. In a patient with known obstructive disease it is a useful measure of the degree of obstruction and so is routinely used in asthma to assess severity and response to therapy. Normal values are calculated on height, sex and age and have a large variability.

    In restrictive lung disease, PEFR is similarly reduced as lung volume is the major determinant of the flow rate in the effort-independent part of the flow-volume curve. Thus PEFR alone cannot distinguish obstructive from restrictive disease.

    Lung volume on the flow-volume curve is also a distinguishing feature of lung disease. In restrictive disease, FVC is lost “from the top” with inspiration limited by disease but expiratory flow rates slightly increased at low volumes because of increased elastic recoil in the lungs. In obstructive disease, FVC is lost “at the bottom” as airway closure occurs prematurely in expiration and the patient is forced to operate at higher lung volumes.

b. Outline methods used for measuring mechanics of breathing including flow-volume loops and interpret such results.

    Volume-time curves are easily measured using mechanical devices such as the Benedict-Roth spirometer (traditionally) or bellows Vitalograph. The tracings produced by these devices are cumbersome to turn into flow-volume curves as the tracing needs to be differentiated with respect to time to yield flow.

    Practically, a pneumotachograph can be used to produce flow-volume curves. This is a tube with a section of fine parallel tubes in it which induce laminar flow. Pressure transducers either side of the laminar flow section measure the pressure drop across the
section of laminar flow and thus the flow rate can be calculated if the length of the section of laminar flow and the characteristics of the gas are known. This is recorded electronically and can be integrated with respect to time to yield volume expired and thus flow-volume curves.

PEFR is measured in isolation using a Wright peak flow meter. This is a chamber in which a leaf is pushed against a spring by the expiratory flow. Its excursion is calibrated to expiratory flow and it moves a pointer which remains at the point of furthest excursion of the leaf (highest flow). These devices are cheap and the results readily reproducible with practice and maximal effort.

c. Describe the carbon dioxide and oxygen response curves and how these may be used to assess the control of breathing.

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d. Interpret and explain normal and abnormal blood gases

In Acid-Base (1.F)

e. Describe the measurement of lung volumes including functional residual capacity and residual volume.

In Respiratory Mechanics (1.B.3)