RESPIRATORY VOLUMES AND CAPACITIES

Four different pulmonary lung volumes are present, which, when added together equal the maximum volume to which the lungs can be expanded. The significance of each of these volumes is given below:

1. The tidal volume is the volume of air inspired or expired with each normal breath, and it amounts to about 500 milliliters in the average young adult man.
2. The inspiratory reserve volume is the extra volume of air that can be inspired over and beyond the normal tidal volume, and it is usually equal to approximately 3000 milliliters.
3. The expiratory reserve volume is the amount of air that can still be expired by forceful expiration after the end of a normal tidal expiration. This normally amounts to about 1100 milliliters.
4. The residual volume is the volume of air still remaining in the lungs after the most forceful expiration. This volume averages about 1200 milliliters.

THE PULMONARY CAPACITIES

In describing events in the pulmonary cycle, it is sometimes desirable to consider 2 or more of the pulmonary volumes together. Such combinations are called pulmonary capacities. The different pulmonary capacities are described as follows:

1. The inspiratory capacity equals the tidal volume plus the inspiratory reserve volume. This is the amount of air (about 3500 ml) that a person can breathe beginning at the normal expiratory level and distending the lungs to the maximum amount.
2. The functional residual capacity equals the expiratory reserve volume plus the residual volume. This is the amount of air remaining in the lungs at the end of normal expiration (about 2300 ml).
3. The vital capacity equals the inspiratory reserve volume plus the tidal volume plus the expiratory reserve volume. This is the

maximum amount of air that a person can expel from the lungs after first filling the lungs to their maximum extent and then expiring to the maximum extent (about 4600 ml)

4. The total lung capacity is the maximum volume to which the lungs can be expanded with the greatest possible inspiratory effort (about 5800 ml). It is equal to the vital capacity plus the residual volume.

Note- All pulmonary volumes and capacities are about 20% to 25% less in woman than in man, and they obviously are greater in large athletic persons than in small asthenic persons.

RESTING EXPIRATORY LEVEL

Normal pulmonary ventilation is accomplished almost entirely by the muscles of inspiration. On relaxation of the inspiratory muscles, the elastic properties of the lungs and thorax cause the lungs to contract passively. So, when all inspiratory muscles are completely relaxed the lungs return to the relaxed state called the resting expiratory level. The volume of air in the lungs at this level is equal to the functional residual capacity or about 2300 milliliters in the young adult.

SIGNIFICANCE OF PULMONARY VOLUMES AND CAPACITIES

In normal persons, the volume of air in the lungs depends primarily on body size and build. The different volumes and capacities change with the position of the body, most of them decreasing when the person lies down and increasing on standing.

This change with position is caused by 2 major factors:

i. A tendency for the abdominal contents to press upward against the diaphragm in the lying position.

ii. An increase in the pulmonary blood volume in the lying position, which correspondingly decreases the space available for pulmonary air.

SIGNIFICANCE OF THE RESIDUAL VOLUME

The residual volume represents the air that cannot be removed from the lungs even by forceful expiration. This is important because it provides air in the alveoli to aerate the blood even between breaths. Were it not for the residual air, the concentrations of oxygen and carbon dioxide in the blood would rise and fall markedly with each respiration which would certainly be disadvantageous to the respiratory process.

SIGNIFICANCE OF THE VITAL CAPACITY

Other than the anatomical build of a person, the major factors that affect the vital capacity are:

i. The position of the person during the vital capacity measurement.
ii. The strength of the respiratory muscles.
iii. The distensibility of the lungs and the chest again (referred to as Pulmonary Compliance).

Note- The average vital capacity in the young adult man is about 4.6 liters, and in the young adult woman is about 3.1 liters, although these values are much greater in some persons of the same weight than in others. A tall, thin person usually has a higher vital capacity than an obese person, and a well-developed athlete may have a vital capacity as great as 30% to 40% above normal, i.e., 6 to 7 liters.

VITAL CAPACITY FOLLOWING PARALYSIS OF THE RESPIRATORY MUSCLES

Paralysis of the respiratory muscles which often occurs following spinal cord injuries or poliomyelitis, can cause a great decrease in vital capacity, to as low as 500 or 1000 milliliters, barely enough to maintain life. This decrease may be even lower in the case of respiratory patients.

DECREASED VITAL CAPACITY CAUSED BY DIMINISHED PULMONARY COMPLIANCE

Any factor that reduces the ability of the lungs to expand also reduces the vital capacity. Thus, tuberculosis, chronic asthma, lung cancer, chronic bronchitis and fibrotic pleurisy can all reduce the pulmonary compliance and thereby decrease the vital capacity. For this reason vital capacity measurements are among the most important and yet simplest of all clinical respiratory measurements for assessing the progress of different types of pulmonary fibrotic diseases.

CHANGES IN VITAL CAPACITY RESULTING FROM PULMONARY CONGESTION

In left heart failure or any other disease that causes pulmonary vascular congestion and edema, the vital capacity becomes reduced because excess fluid in the lungs decreases lung compliance,

Vital capacity measurements made periodically in left-sided heart failure are a good means for determining whether the person’s condition is deteriorating or getting better, for those measurements can indicate the degree of pulmonary edema.