Aerosol Therapy

Essay

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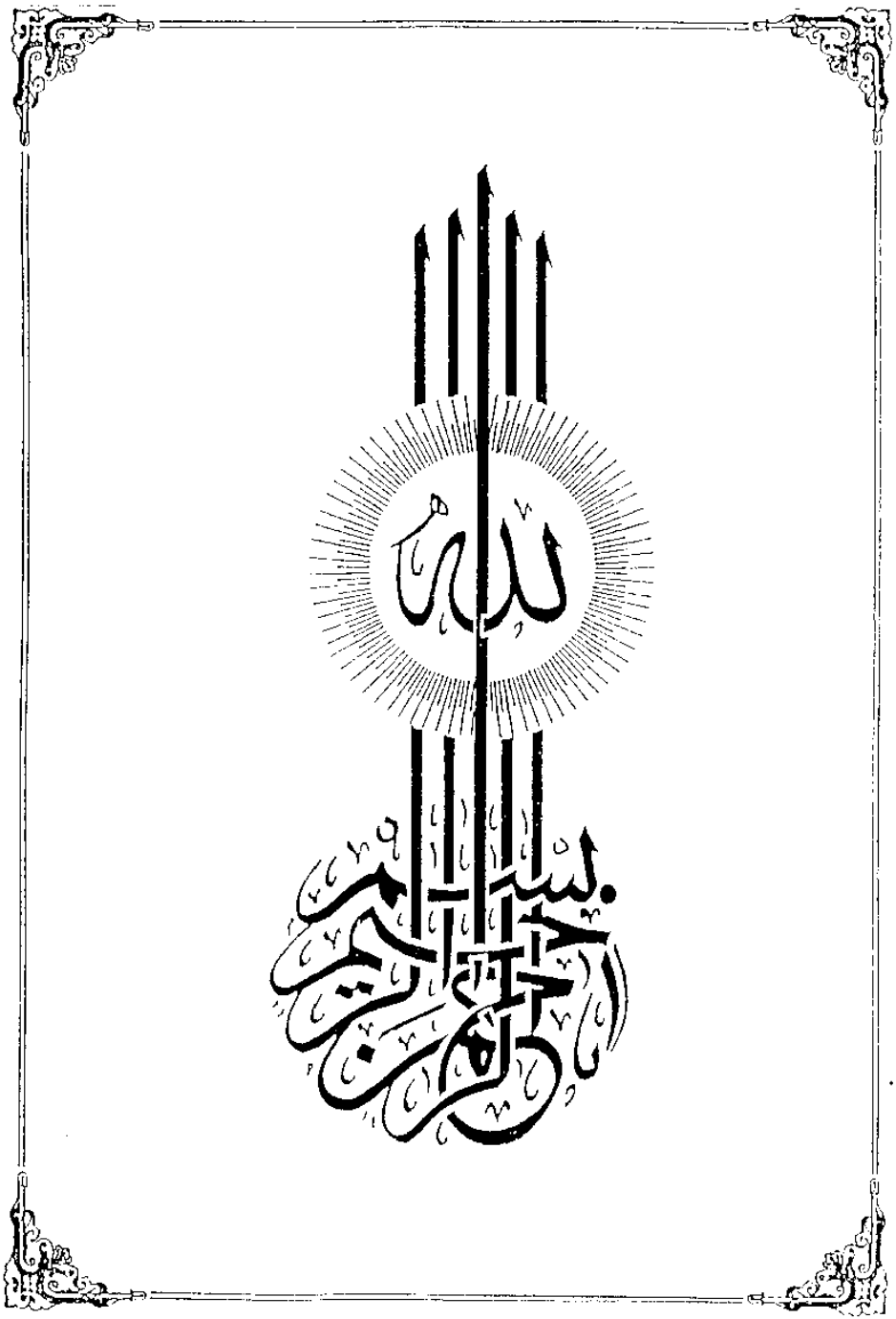
بسم الله الرحمن الرحيم

"سبحانك لا علم لنا إلا ما علمتنا، إنك أنت العليم الحكيم"

صدق الله العظيم.



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INTRODUCTION

AEROSOL THERAPY

Introduction:

The air reaching the larynx, trachea, and bronchi during quiet breathing is fully saturated with water vapor at body temperature despite wide variations in ambient temperature and relative humidity. Such adequate warming and humidification of the inspired air is necessary for normal function of the respiratory tract.

Thus,the aim of humidification is to maintain normal function and a physiological environment of the respiratory mucosa, and to restore a free airway by liquefaction of retained dry secretions. The amount of water that must be added to the inspired gas depends upon a number of factors. The minimum requirement for humidification is that the inspired gas must reach the trachea saturated with water vapor at body temperature. The choice of humidifying equipment is influenced by the extent to which the normal himidifying area of the upper airway is by passed and on the extent to which a previously inadequate humidification and a negative water balance have led to drying of the mucosa. Such varying requirements for humidification mean that a variety of equipment must be available and that the selec-

tion must be made on an individual basis. Modern respiratory care incorporates equipment as simple as a nasal cannula or as sophis ticated as a microprocessor-controlled mechanical ventilator. Contomporary clinical anaesthetic practice necessitates thorough knowledge of respiratory therapy devices as well as their mechanical characteristics and limitations. This subject of clinical inhalational therapy with aerosols was chosen because the use of water in the treatment of bronchopulmonary disease requires an understanding of the principles of aerosols, and we will see that of all the pharmacologically and physically active areosols,water is the most important. From this point on,an attention will be directed primarily toward the patient -his needs,and how we can best serve these needs. Some basic principles will be considered besides what the patient may need. Also different physical and chemical fundamentals will be covered in this subject.

TYPES OF AEROSOLS

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An aerosol is defined as a suspension of very fine particles of liquid or solid in a gas. In general aerosol particles are considered to fall within the size range of 0.005 microns to 50.0 microns in diameter, for it is at this mass size that gravity begins to lose its influence.

Atmospheric aerosols can be considered either naturel or man made and may consist of wind blown dusts, bacteria, yeast, molds... etc.

Another classification of atmospheric particulate matter which is especially revealing in its relationship to disease production,is that which describes neutral particles,commonly referred to as dusts and "condensation nuclei". These nuclei range in size from 10-7 to 10-5 cm in diameter and are composed mostly of chloride salts,sulfuric acid, phosphorus compounds, nitrogen oxides,and nitric acid. In the air,such nuclei grow rapidly in size by the acquisition of water,as the relative humidity exceeds 70% and easily produce haze and fog. It should be apparent also that any hygroscopic aerosol might undergo the same change during inhalation into the moist environment of the respiratory tract.

PHYSICAL PROPERTIES OF AEROSOLS

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Stability: stability of an aerosol refers to its ability to remain in suspension for significant periods of time or,in fact,to maintain its integrity as an aerosol. Numerous characteristics affect this stability. Among the more important are:

(1) concentration of particles.

(2) Size and nature of the particulate matter.

(3) Ambient humidity .

(4) The degree of mobility of the carrier gas.

Instability is the tendency for particles to remove itself or be removed from suspension. The stability or instability of an aerosol will greatly affect its clinical usefulness.
Medical aerosols are believed to have optimal stability when the particle diameter is from 0.2 to 0.7 micron and the concentration are from 100 to 1000 particles per cubic centimeter of gas. We must accept the generalization that water particles (or salt water particles) are reasonably stable in the 0.5 to 3 micron diameter range,and that these particles maintain a basically spherical state under normal conditions (Allan D.1966).

A medical aerosol must traverse tubular structures in which turbulent flow is the rule. Water or salt water solutions will not change basic chemical or physical properties when inhaled,

and they have the tendency to coalesce when contact is made; i.e. when two particles of water collide, they tend to form one larger particle.

Water particles have the physical tendency to form spheres, so that the least surface area is exposed to the gas . Since the volume of a droplet is proportional to the cube of its diameter,one thousand 4 - micron particles must coalesce to form a single 40 micron diameter particle (Egan 1973). In general, as droplets travel down the pulmonary tree, turbulence will cause the particles to collide and form larger diameter particle (Fig.I). Related to the characteristics of stability and instability, but especially pertinent to the therapeutic use of aerosols, are penetration, deposition or retention and clearance, terms that are descriptive of the fate of particles once they have come into contact with the repiratory tract. Because of the importance of these physical properties in the clinical aspect, they are going to be discussed in more detail.

PENETRATION AND DEPOSITION OF AEROSOLS

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These are terms which describe the fate of particles once they have come into contact with the respiratory tract.

"Penetration" refers to the maximum depth that suspended particles respiratory can be carried into the tract by the inhaled tidal air.

"Deposition" is the result of an aerosol's eventual instability, permitting it to fall out on a nearby surface.

"Retention" implies the deposition of a particle within the confines of a structure such as the repiratory tract.

"Clearance" refers to the process of removal of particles once deposited in the pulmonary tree. Of significance is the location of the deposition of inhaled particles, for there is a considerable physiologic difference between particle contact with the relatively rugged and exposed nasal tissue and particle contact with the more secluded and reactive bronchial and alveolar cells which are of more interest in the therapeutic use of aerosols. The depth of penetration of the respiratory tract increases as the particle size decreases as in table (1). In fact unless a particle is considerably less than 100 microns in dimeter, it will not even gain entrance. The nasal filtering process is so effective that it will remove completely particles