HUMIDIFICATION OF INHALED GASES

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VAPOTHERAPY has, for generations, been recognized as an effective way to humidify inspired air and to carry medication through the respiratory tract.

Medical gases delivered to the patient's airway are usually delivered in their purest form. In order to elevate the purity standard, all moisture is removed from them. The use of gases entirely lacking in humidity, is not compatible with the ventilatory systems of the human body. The breathing of dry gases for a relatively short time will result in drying out of the mucosa and the eventual dehydration of the patients.

The humidification in the form of aerosol, provided by mechanical means, is a technique carried out by the nursing staff and the other para-medical staff. So, the staff must be familiar with the various mechanical principles employed in the construction of the many types of humidifying apparatus used by the speciality. Moreover, the knowledge acquired by the staff, both in practice and theory should be beneficial to raise their individual standard for providing professional advice on the purchase of equipment.

Nearly, all inhalation therapy procedure require aerosolization. An aerosol is a suspension of particles (usually a solution) in a gas. In the present context the term refers to a visible mist or fog of liquid particles in a carrier gas, and implies a fairly stable mist. Air or oxygen or a mixture of these gases is by far the most common vehicle. Atomizer usually means something squeezed by hand to generate particle, and an equipment providing a finer mist is usually called a Nebulizer. Nebula means a fog or mist or any cloudy mass consisting of particles small enough to float.

Before discussing the principles employed in humidifiers, some important factors concerning humidity should be reviewed.

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Vaporization is influenced by temperature and pressure. The warmer the air, the more vapour it can hold. The effect of pressure on vaporization is an inverse one in that if pressure is increased or decreased, vaporization will be retarded or increased respectively. The Absolute Humidity is the measurement of the actual amount (weight) of water per volume of air—Grams/Cu. meter of milligrams/litre or pounds/Cu. foot. The relative humidity is a comparision of the content of water in a given volume of air (A.H.) and the amount of water the air can hold at a given temperature if saturated (capacity). The instrument to measure RH is called hygrometer.

It is proved that inhalation of 100% saturated gas at 70°F into bronchial tree, temperature of which is 90°F results in a 70% saturation. The normal optimum is 60% of humidity at the temperature of 70°F. When the size of moisture particles are large, they are of limited value therapeutically, despite the fact that total moisture content falls into adequate range. The measurement used for moisture particle size is the Micron. That is, one micron is equal to one particle 1/1000 of a millimeter in diameter. In humidification therapy the effective particle size range from 0.5 micron to 10 micron.

The most common principle employed in the construction of the many types of humidifiers are diffusion, moisture exchanger type, water bath type, pneumatic-jet, centrifugal force, and ultrasonic nebulization.

Diffusion Type

Gas is forced through a porous stone or small holes into a liquid. Gas in the form of bubbles, will be forced through the liquid, picking up moisture on the way and it is pushed into the air stream to the patient's breathing circuit. There are two types, one is Ball type and the other is Porous Stone. They produce humidity in the range of 10 to 50% saturation.

Moisture Exchanger Type

This type of condenser humidifier sets as an artificial nose. It is a small container with closed meshed nickel screens serving as humidity condenser is interconnected between patient's endotracheal/tracheostomy tube and sorce of external air. The expiration air is led over these screens, where-by the exhalation humidity condenses. During inspiratory phase the dry inhalation air is moistered intensively by the condensing water on the screen. Thus the dry respiratory gas is humidified by the water vapour contained in the expiration air and simultaneously warmed up. It provides more than 90% of relative humidity. But, it is not suitable for use in infant or small children.

Water Bath Type

The gas stream is passed across the surface of a heated, thermostatically controlled water bath, The adjustable temperature control permits variation in the reservoir water temperature and so the temperature of the delivered gas stream. By raising the temperature in the humidifier slightly above body temperature it is possible to deliver gases to the patient which are at 37°C and completely saturated with water vapour. This type of humidifier, when combined with a fan to blow air through it can be used to humidify a tracheostomy.

Pneumatic Jet Type

This type of humidifier is called pneumatic nebulizer. This operates on Venturi principle, which was established by Daniel Bernoulli in the eighteenth century. A simplified explanation is that the greater the linear velocity, the lesser the lateral pressure. The pneumatic usually operates on the basis of compressed Oxygen or air flowing across the office of a very fine capillary tube which communicates aerosol solution, and then against a baffle plate or ball, which prevents escape of the larger droplets and allows the passage of a very fine mist. There are two common variations—i.e. Jet Humidifier and Fog Generator.

Centrifugal Force

A disc spinning at great speed will produce a sub-atmospheric pressure on its underside. If suspended over a large container of water, particles will be drawn up to the disc and thrown off centrifugally from its outer edge. By placing a specially constructed baffle at the outer edge of the disc, particle size can be reduced. The motive force for dispersion yields uniform densely suspended particles of relative stability. It produces a particle size of 3 to 13 micron.

Ultrasonic Nebulization

The ultrasonic generator is fitted to focusing type piezo-electric transducer. It is electrically powered and provides particles of small diameter; a much denser and uniform mist. There are two types, distinguished by the kind of crystal used. Both are similar in function. When energized, the transducer changes high thickness at a fixed frequencies, ranging from about 0.75 Mh to 3.0 Mh. The water to be nebulized is fed on to a glass plate in the nebulizer chamber via a peristalic pump. The intense vibrations, which are transmitted to the glass plate from the plezo-electric transducer via a coupling medium of distilled water, break up the water drops into particles smaller than three micron. These floating particles are then taken up by the gas flow through the nebulizing chamber.

Clinical Aspects

Most of the humidification during normal conditions occurs in the nose and only about 130 grams of water out of a total of about 500 grams per 24 hours is added from the airway below the laryn. After trachaeostomy with an inserted cannula or after intubation, the equivalent amount is only about 70 grams of water. The total water-loss of the airways when breathing room-air of normal humidity in a tracheostomized adult patient amounts to about 400 to 800 grams of water per 24 hours. The addition of the proper amount is required because without this, the patient's airways tend to dry up and cillary activity declines rapidly, causing plug formation, infection etc. Some means must be found of raising the relative humidity of the breathed gas to 100% or as near to it as possible, in order to replace the function of the temporarily by-passed natural airways. The temperature of the gas should also be raised to within a few degrees of body temperature. In inhalation therapy, sterile

distilled water is one of the most important agent used in aerosol form. The physiologic saline (0.9% Normal Saline) can also be used as humidifying agent. But, in the long term procedure, it is prefered to use half-strength "physiologic saline" (0.45% saline), because when 0.9% saline moves down the airway and loses water it becomes hypertonic.

Nebulizers have been used in a wide variety of respiratory conditions including upper respiratory infections, laryngotracheobronchitis, pneumonia, tracheo-oesophageal fistula, and bronchial asthma. Although nebulizers are primarily used for humidification for dry gases in inhalation therapy, there are other clinical applications growing importance. They are used in diagnosis for sputum inducement and for performing inhalation lung scans.

One of the most frightening aspects of inhalation therapy is associated with its use in a patient who has a lung infection. Multiplication of vegetative micro-organisms in the humidifiers can occur rapidly. This can be prevented in water bath type either by filling humidifier with a solution of 0.1% Chlorhexedine in distilled water, or by maintaining the water in the humidifier at a Pasteuring temperature of 60°C. In a similar manner, the other type of humidifiers can be treated with 0.1% solution of Chlorhexedine by running the equipments for a period. Formaldehyde vapour can also be used to sterilize the humidifiers, but the residual formalin should be neutralized with ammonia vapour blown through the same. Ethyl-alcohol 70% or Isopropyl-alcohol 70% can also be used as a sterilizing agent. This is suitable for humidifiers other than water bath type.

Care of the Humidifier

The container and humidifying unit should be thoroughly cleaned. The mineral in solution—used for humidification may clog the tiny openings in he diffuser head and/or humidifying assembly. Hence, the patency of all tubes and orifices are to be checked. Some units have felt diffuser heads which must be changed periodically. If the unit has a filter screen and a rubber washer in the container cap, both should be removed and cleaned. When a humidifier is permanently assigned to areas such as Resuscitation Unit, Intensice Care Unit etc., daily care of the equipment is most important. If the equipment is in use, it should be replaced with a clean unit once every 24 hours. When solution is reservoir becomes low, it should be discarded and refilled with fresh solution after rinsing the container. If humidifier is on stand by, the entire unit should be sterilized at least once a week. After sterilizing the entire unit, it should be allowed to dry before assembling for storage.

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The International Conference of Psychiatric Nursing will be held between September 8th-12th at Imperial College London. This is the first international conference to be presented by psychiatric nurses for psychiatric nurses to be held in the U.K. and the programme is being arranged by the Bethlem Royal and Maudsley Hospital in conjunction with the "Nursing Times" journal. For further information write to: **International Conference of Psychiatric Nursing, Miss Pat Young, Conference Consultant, Nurs ng Times, 4, Little Essex Street, London, WC2R 3LF.**