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CHAPTER 10

AIR CONDITIONING IN THE PREVENTION AND TREATMENT OF DISEASE

Influence on Patients; Control of Airborne Infection; Operating Rooms: Explosion Hazard, Room Conditions; Nurseries for Premature Infants: Requirements, Equipment, Control of Airborne Infection; Patient Rooms; Allergic Disorders; Hyperthermia; Hypothermia; Fog Therapy; Oxygen Therapy; Pollutants; Odors; Maintenance of Air Conditioning Systems

AIR CONDITIONING complements biologic processes for the exchange of heat and water and removes most of the hazardous particles or offensive products of human activity from the environment. Its purposes can best be achieved once the basic physiologic functions are understood.

Temperature regulation in the human is summarized diagrammatically in Fig. 1. Heat loss in a resting individual occurs by three processes: vaporization from the skin and lungs, 25 percent; radiation from the skin, 60 percent; and convection, 15 percent. Loss by conduction from a clothed individual is negligible. Shade, cool surroundings, air currents, and immersion in cold water are conventional means of increasing heat loss. As the ambient temperature reaches that of the body, these methods are ineffective, and therefore control of relative humidity becomes of paramount importance.[1,2]

The body temperature of an insulated man rises about 3.6 F deg per hour by the retention of heat from his metabolism.[3] Sweating, panting, and more rapid circulation of the blood through the skin are the physiologic methods of augmenting loss of heat.[4] On a hot desert day, a man may produce more than a liter of sweat in an hour. When loss of his body weight approaches 5 percent, physical deterioration results; perception is distorted, and judgment falters. When the loss approximates 10 percent, delirium, convulsions, deafness, and insensibility to pain ensue. Death from explosive heat or heat-stroke results from a 12 percent loss. Death is caused by stagnation of blood flow due to increasing viscosity of the blood. Metabolic heat can no longer be dissipated to the skin and respiratory tract, and body temperature rises to a fatal level.

The role of the skin in temperature regulation of the body is widely recognized. The more remarkable part played by the respiratory tract is little appreciated. Air conditioning is important because it can compensate for critically aberrant body functions in this vitally important area.

The temperature and relative humidity of inspired air are brought to body temperature and to a saturated level, prior to reaching the lungs, by turbulent convection and evaporation of water from the mucosa (mucous membranes) lining the upper respiratory tract (Fig. 2).[4] When the inspired air is cooler and drier than alveolar air (the air in the lungs), these processes cool the mucosa. During expiration, heat and water are recovered from the alveolar air (98.6 F, 100 percent RH) as it impinges on the colder mucosa of the nasopharynx (Fig. 3). The amount of this exchange depends upon the degree to which the alveolar air is cooled by the mucosa. Since the cooling of the mucosa is dependent upon the ambient temperature and humidity, it is these factors that determine the heat and water balance that results from respiration.

In hot climates, the ambient humidity is critical in determining heat loss. When hot, saturated air is inspired, insignificant evaporative cooling occurs; indeed, the nasopharyngeal mucosa may gain heat from inspired air and water vapor that condenses on the cooler mucosa. During expiration, alveolar air is discharged fully saturated at 98.6 F. Under these conditions, the body nets a gain in both heat and water. Lowering the relative humidity permits evaporative cooling to

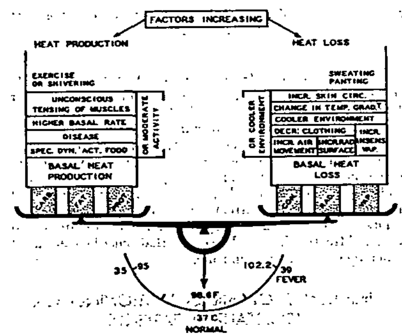

Fig. 1 .... Balance Between Factors Influencing Heat Production and Heat Loss[1]

The general responsibility for this chapter is assigned to TC 1.4, Physiology and Human Environment.