

occur and enables the body to remain in heat and water balance.

The capacity of the respiratory tract to maintain heat and water balance in comfortable ambient conditions depends upon the integrity of the mucosa. Inflammation of the mucosa, an increase in its temperature, or changes in its surface impede this vital function. During periods of fever, increased heat (7 percent per F deg fever) and water are dissipated. This reduces body temperature but causes excessive water loss. The ideal therapeutic environment for the person is a cool, dry, ambient condition which enhances the dissipation of heat from the respiratory tract and the skin. Water loss must be replenished systematically, particularly when hyperventilation exists.

Patients with chronic pulmonary disease are often plagued

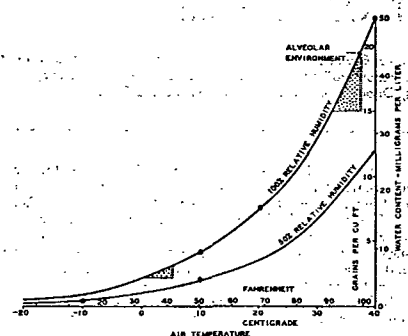


Fig. 2.... Relation of Inspired Air Temperature to Humidity⁴

by viscous respiratory-tract secretions. As these accumulate and increase in viscosity, the exchange of heat and water dwindles. Warm, humidified, inspired air is essential to prevent dehydration under these circumstances.

Patients requiring oxygen therapy or those with a tracheotomy (an artificial opening into the windpipe) require special attention to assure a warm humid supply of inspired air. The cold dry oxygen or the bypassing of the nasopharyngeal mucosa presents the extreme situation. Rebreathing techniques for anesthesia and enclosure in an incubator are special means of treating impaired heat loss that must be considered under therapeutic environments.

INFLUENCE OF AIR CONDITIONING ON HOSPITALIZED PATIENTS

Hospital air conditioning assumes a more important role towards patients than the promotion of comfort. In many cases, proper air conditioning is a factor in the therapy of the patient, and, in some instances, it is the major treatment.

An analysis of patients in a partially air-conditioned hospital where the ambient climate is normally hot and humid has revealed an improvement of vital signs in those patients hospitalized in the air-conditioned wards as compared to the group assigned to the unconditioned part of the hospital. The air-conditioned group was quieter and had more rapid physical

improvement. The greatest difference was in the perspiration rate, a factor of importance to cardiac patients in particular.

The difficulty encountered in maintaining fluid and electrolyte balance in patients suffering from burns in temperate climates is tremendously increased in hot environments by additional evaporative fluid loss. Naval hospital ships having all wards, laboratories, and living spaces air cooled, represent a notable achievement in the control of environmental factors for the purpose of providing better treatment of patients, especially those suffering from extensive burns.

Patients with thyrotoxicosis tolerate hot humid conditions or heat waves very poorly. Their metabolism is high, and therefore their heat production is excessive. They may be unable to eliminate heat from the body surface as rapidly as it is produced and transported to the skin. They develop hyperthermia or fever, and a tachycardia or rapid heart rate. The demand on the circulation for transport of heat from the interior of the body to the skin surface is increased. The increased body temperature leads to increased cell metabolism, and in turn to still greater heat production. This vicious cycle may threaten life if the cardio-vascular or transport mechanism breaks down. A cool, dry environment favors the loss of heat by radiation and evaporation from the skin, and may save the life of the patient.

Cardiac patients may be unable to maintain the circulation necessary to insure normal heat loss. Recently the importance of air conditioning hospital wards and rooms of cardiac patients, particularly those with congestive heart failure, has been stressed as a therapeutic measure.⁴ It is more important in tropical or subtropical climates. Individuals with head injuries, those subjected to brain operations, and those with barbiturate poisoning may have hyperthermia, especially in a hot environment, due to a disturbance in the heat regulatory center of the brain. Obviously, one of the most important factors in recovery is an environment in which the patient can lose heat by radiation and evaporation, namely, a cool room with dehumidified air.

A hot dry environment (89.6 F and 35 percent relative humidity) has been used over an extended period for the treatment of patients with rheumatoid arthritis, with reported improvement.⁷

CONTROL OF AIRBORNE INFECTION

The Council of Physical Medicine of the American Medical Association approved the radiant disinfection of air in 1943, and two sub-committees of the Committee on Research and Standards of the American Public Health Association have reported favorably upon the control of airborne infection by sanitary ventilation and on air sanitation respectively.^{8,9,10,11}

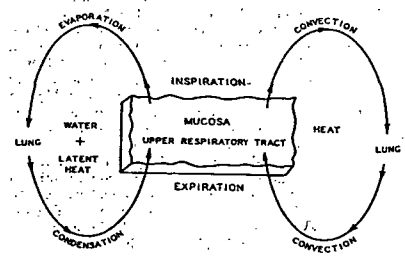
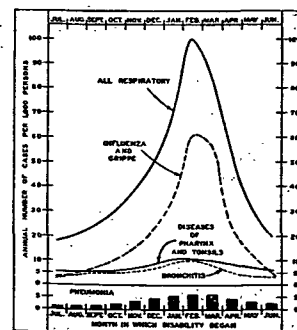


Fig. 3.... Heat and Water Exchange During Respiration⁴

Air Conditioning in the Prevention and Treatment of Disease

The ASHAE Technical Advisory Committee on Air Sterilization from 1944 to 1949 reported progress in The ASHAE JOURNAL SECTION, *Heating, Piping, and Air Conditioning* and recommended a set of definitions, formulations and factors for joint adoption by the American Public Health Association and the Society. The following paragraphs give some idea of the scope of the subject.

The majority of airborne diseases are spread indoors where people gather. Today the unsolved problem of staphylococci infection contracted in hospitals now far exceeds and also complicates the respiratory infection problem. Any program of air sanitation is influenced by a number of factors. In the winter months, the closing of doors, windows, and other means of access to the outdoor air to conserve warmth, as well as the crowding of persons indoors, provides conditions conducive to a high incidence of contagion. This seasonal phenomenon, illustrated in Fig. 4 which represents a study made by the U. S. Public Health Service, will concern the ventilating engineer insofar as air quality (determined by temperature, humidity, air replenishment, type of air movement, and freedom from contamination) is a major intrinsic factor. Apart from the seasonal picture of airborne contagion are such extrinsic factors as rate of turnover of personnel, and the marked susceptibility of the recruit as compared with permanent personnel¹² as shown (see Fig. 5) by studies of military personnel housed in barracks. These extraneous variables and the factor of contact infection (direct spray) tend to complicate any evaluation of the effectiveness of air sanitation for elimination of microorganisms in droplet-nuclei and droplet-dust. Thus, control measures may eliminate consistently 90 percent of airborne organisms in laboratory tests, but may not effect a decrease in actual incidence of infection exceeding 30 percent. Thirty percent may be the maximal reduction in infection possible by air treatment methods. The distinction should be clearly drawn, therefore, between the effectiveness of a procedure in laboratory tests and its effectiveness and applicability in actually reducing the incidence of airborne disease. On the other hand, recent studies suggest that inhalation of dust-borne bacteria is more



Occurrence of diseases causing disability for 8 consecutive days or longer in a group of 100,000 wage earners (10 percent women) in different industries.

Fig. 4.... Study of Average Monthly Frequency (1921-1926 Inclusive) of Specified Respiratory Diseases.

important than direct inhalation of infectious droplets or droplet nuclei in the spread of respiratory tract infections.¹⁴

The following sequence of events has been postulated as occurring in a large proportion of intra-ward infections: (a) ejection of relatively large protected infective particles from patients, (b) rapid venting or settling of these particles so that those remaining airborne are in low concentration, (c) survival of infective particles to permit the accumulation of high concentrations on surfaces, (d) repeated reintroduction of infective particles into the air, under the stimulus of ward activities or by air currents of the order of 50 fpm over the floor, and (e) extension of infective areas by air turbulence throughout the ward or hospital. The most important link in this probable infection chain has been demonstrated to be the reintroduction of particles into the air.¹⁴

Intensive studies on air disinfection have indicated two distinct control measures: (a) suppression of dust and lint,

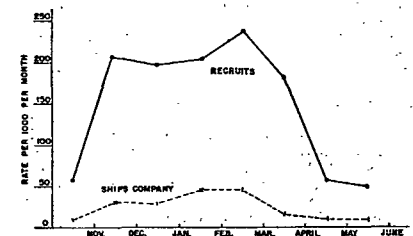


Fig. 5.... Monthly Incidence of Acute Respiratory Illness Among Naval Recruits and Ship's Company (Permanent Personnel)¹³

and (b) disinfection of droplet-nuclei. A third measure, control of relative humidity, is important. It has been shown that the viability of certain organisms sprayed into the atmosphere from a liquid suspension is dependent on relative humidity. The mortality rate of the organisms is very high at a relative humidity of 50 percent,¹⁵ and decreases at humidities above and below this figure. It has also been reported that the influenza virus loses much of its virulence when the relative humidity is 50 percent.¹⁶

Well controlled, large scale tests of the various methods of air sterilization conducted in barracks^{17,18} have confirmed the importance of dust control in minimizing the spread of airborne disease, a consideration which has guided the practices of ventilating engineers for a number of years. The importance of the dust factor has been emphasized by many engineers, and has been convincingly demonstrated by subsequent bacteriological studies aboard ships.

Ultraviolet radiation of floors and upper air was studied extensively at the Naval Training Center, Sampson, N. Y. In barracks housing naval recruits, hospital admissions for respiratory infections (mostly *catarrhal fever*) were 25 percent lower in a group of men exposed to ultraviolet radiation—2537 Angstrom Units, 1 to 7 ergs per (cm²) (sec) at bed level, than they were in adjacent control barracks without ultraviolet radiation.¹⁹

A controlled study over a six-year period on the evaluation of ultraviolet radiation of sleeping quarters as a sup-