ments of the majority of premature infants. Additional heat for weak (or debilitated) infants may be furnished in the cribs or by means of electric incubators placed inside the conditioned nursery, with temperature adjusted according to individual requirements. In this way a multiplicity of chambers and of air-conditioning apparatus is obviated; the infants in the heated beds derive the benefit of breathing cool humid air, and the nurses and doctors need not expose themselves to extreme conditions.

Importance of Humidity: Although external heat is an important factor in the maintenance of normal body temperature, humidity appears to be of equal or greater importance. When the premature nurseries at the Children's Hospital were kept at relative humidity between 25 and 50 percent for two weeks or longer, the body temperature became unstable, gain in weight diminished, the incidence of gastro-intestinal disturbances increased, and the mortality rose. On the other hand, continuous exposure to air conditions with 55 to 65 percent relative humidity gave satisfactory results over a period of years. The initial physiologic loss of body weight (loss occurring within first four days of life) was found to vary inversely with the humidity. In the old nurseries with natural humidity it averaged 12.4 percent of the birth weight; in the conditioned nurseries it was 8.9 percent with 25 to 49 percent relative humidity, and 6.0 percent with 50 to 75 percent relative humidity. The number of days required to regain the birth weight was correspondingly maximum in the old nursery, and minimum in the conditioned nurseries under high humidity.

Maximum gains in body weight occurred in the conditioned nurseries under high humidity (55 to 65 percent) in infants weighing less than 5 lb. The gains were less under low humidity (25 to 50 percent) in the same nurseries, and in the old nurseries prior to use of air-conditioning apparatus.

The incidence and severity of digestive syndromes, with diarrhea, persistent vomiting, diminishing gain or loss of body weight, and other symptoms, were generally from two to three times as high under low as under high humidity.

Summarizing, the best chances for life in premature infants are created by maintaining a relative humidity of 65 percent in the nursery, and by providing a uniform environmental temperature just sufficiently high to keep the body temperature within normal limits. Medical and nursing care are, of course, factors of equal and sometimes of greater importance.

Air-Conditioning Equipment

Many of the installations now in use are of the central system type providing for filtration, for humidification and heating in cold weather, and for cooling and dehumidification in hot weather. A ventilation rate between 8 and 12 air changes per hour is desirable to remove odors and maintain uniformity of temperatures in extremes of weather. Recirculation should not be used in these wards because of odors and the possibility of infection. There should be a frequent change in spray water.

Control of Airborne Infection

The protection of the premature and older infant against infection is of the utmost importance. It was found in one installation equipped with air conditioning, germicidal lights and mechanical barriers that air conditioning alone did not prevent respiratory cross-infections.[28] Bacterial ultraviolet barriers, air conditioning, and mechanical barriers are efficient. However, infections are brought in, and often spread, by ward personnel in spite of these measures.

PATIENT ROOMS

Good practice in the air conditioning of hospital patients' bedrooms involves fewer limitations than does that of special purpose areas, and most of the generalizations which apply are discussed in other parts of this chapter. It will be found that each of the several types of systems in common use has its application, that money, space, probable maintenance, and climate all must be taken into account, and that which is chosen should be the best compromise possible in any given situation.

The following are those characteristics which are desirable in a patient room air-conditioning system, and their relative availability should be checked in connection with any system being considered. They are listed, not necessarily in the order of their importance, but in the order in which they might logically be considered.

1. It should be as economical as is compatible with the results desired, both in initial and operating cost and in space.
2. It should afford year-round conditioning according to literal definition. It should be able to deliver heating and cooling simultaneously to various areas as required.
3. It must provide positive automatic temperature control. It should provide positive automatic temperature control on a room by room basis and a range of maintained temperature from 70 degrees to 85 degrees summer and winter is desirable.
4. Recirculation between rooms should be avoided in order to minimize the possibility of cross-contamination.
5. Wet coils for recirculated air are best avoided on account of their tendency to accumulate and release odors. If used, they should be arranged for easy cleaning.
6. It should include the most effective filtration possible; the best is none too good.
7. It should involve air motion sufficient to avoid stagnation but with room velocities, especially across floors, kept low in order to minimize the reentry of dust.

ALLERGIC DISORDERS

Hay fever, asthma, eczema and contact dermatitis are classified as allergic disorders. The allergic individual responds to contact with a variety of substances, which are innocuous to a non-allergic person, with severe manifestations of hypersensitivity.

These substances are known as allergens and consist of airborne irritants such as dusts, molds, feathers, pollens, animal dander and others; of food protein such as milk, wheat, eggs, etc., or of simple chemicals brought in contact with the skin. They may enter the body by various routes of which inhalation is the most common type. Ingestion of offending food substances is not infrequent.

The offending substance reacts with the sensitized cells of the mucous membranes or skin. During this reaction, histamine or a histamine-like substance is released and causes (a) increased capillary permeability, (b) secretion of mucus and (c) muscular contraction. In the eyes and nose this produces itching, redness and lacrimation or rhinorrhea, in short, the symptoms of hay fever. In the lungs it causes, in addition to the secretory response, a contraction of the smooth muscles of the bronchi resulting in a bronchial asthma.

It is commonly known that non-specific environmental factors such as dust, irritating gases, change of temperature and humidity may precipitate asthmatic attacks in allergic subjects, even in the absence of exposure to specific allergens. It is assumed that the presence of frequent allergic bronchial constriction renders the smooth muscles of the bronchi so sensitive to various non-specific stimuli that the threshold of their response to such irritation is considerably lower than that of a non-allergic individual.

Air-Conditioning Apparatus

Of all the measures to relieve a specifically sensitive individual, elimination of exposure to the responsible allergen is the most efficient, though not always a practical, form of treatment. In recent years considerable effort has been made to accomplish such elimination by removal of respiratory allergens from enclosures by filtration or other air-conditioning processes.

Paper or cloth filters, mounted in inexpensive window or floor units, prove quite satisfactory in many cases, but since dust and smoke frequently cause asthmatic attacks, it is desirable that an air filter, to be of full value in the treatment of asthma, should remove all possible dusts and pollens regardless of size or amount. Electrostatic air cleaners are more efficient than most commonly used types for capturing very fine dust.

Although the chief remedial factor in the treatment by conditioned air is the filtration of pollen, a certain amount of cooling and dehumidification appears to be desirable. A comfortable temperature between 70 and 75 F, and a relative humidity well below 50 percent has proved satisfactory.[29] Direct drafts, overcooling or overheating are apt to initiate or aggravate the symptoms.

Limitations of Air-Conditioning Methods

The results obtained with air filtration, or other air conditioning processes, in the control of allergic conditions, are fairly comparable to those obtained by desensitization treatment, so long as the patients remain in the pollen-free atmosphere. For all practical purposes filtration gives only temporary relief. In mild cases sleeping in an air-conditioned space may make it possible for the individual to pass more comfortable nights. With rare exceptions, the symptoms recur on exposure to pollen-laden air. Moreover, the usefulness of air-conditioning methods is limited, because all cases are not caused by airborne substances. Cases of bacterial asthma do not respond to treatment with filtered air.

Despite these limitations, air-conditioning methods provide definite advantages in the simplicity of treatment, convenience, and, under certain conditions, almost immediate relief.[31] Pollen cases are usually relieved of most of their symptoms within 1 to 3 hr after exposure to properly filtered air. A pollen-free atmosphere is especially valuable when desensitization has given little or no relief, and when desensitization is not advisable owing to intercurrent illness.

SPECIAL APPARATUS

A variety of apparatus has been created for the application of special conditions to be applied to various patients to assist in the cure of specific diseases. Hyperthermia, the deliberate creation of a fever; hypothermia, cooling below normal body temperature; fog therapy, the use of a superhumidified atmosphere; and oxygen therapy are the most important.

HYPERTHERMIA

Hyperthermia is a technique to raise patients' temperatures to points sufficient to kill certain bacteria within them.[32] Gonorrhea, syphilis and pelvic infections were often treated by raising the body temperature to between 104 and 107 F for three to eight hours. The development of antibiotics has made this dangerous procedure unnecessary, and it is now a nearly forgotten technique.

HYPOTHERMIA

Hypothermia was originally used in the 1930's for the treatment of cancer known to be inoperable.[33] It was later shown to be ineffective for this purpose, but the technique had a resurgence recently as an anesthetic for open-heart surgery, brain operations, and liver surgery.[34,35,36] Reduction of a patient's temperature throughout his body, or the isolation of part of his body and localized cooling, lowers the oxygen demand to the point that the blood supply can be cut off temporarily and dry surgery can be done. The development of other techniques, such as the use of pumps to furnish a supply of blood to the rest of the body, has lessened the use of hypothermia, but it is still used and is sometimes coupled with the use of the pump to reduce the obligatory blood flow.[34]

There is a variety in methods of producing hypothermia. One method is to lower the patient into a tank of shaved ice. In another, cold water is circulated through an enveloping mattress to cool the patient. A pump may be used to circulate chilled blood through a specific organ to reduce its temperature. The method is hazardous and slow, but it has permitted successful completion of special surgery.

In its latest role hyperthermia has been used in the rewarming of these patients. Heated electric pads, induction coils, hot baths, infrared lamps, or a long wait for the patient to regain his normal temperature have all been used.[37]

FOG THERAPY

Devices have been installed in patients' rooms to create a heavy, foggy atmosphere.[38] The excess moisture vaporizes when the air is warmed to body temperature on inhalation, preventing water loss. This atmosphere is used for the treatment of respiratory disease and helps to hydrate the thick, tenacious excretions that clog patients' respiratory passages. The therapy, though effective, has its own hazards. The rooms and machines themselves can become overgrown with bacterial and fungal growths. Care must be taken to prevent the spread of disease by painting the rooms with bacteria- and mildew-resistant paint and by a concurrent disinfection of the humidifying and air-conditioning machines.

When a patient is discharged from such a room, it should be cleaned by wiping it down with a bactericidal and fungicidal solution. Beds and furniture should be sprayed with a steam-hydraulic jet cleaner. Mattresses, bedding, and the patient's clothes and belongings should be sterilized in a non-destructive device such as an ethylene oxide gas sterilizer.

OXYGEN THERAPY

Many patients have such decreased capacity for inspiring oxygen from the atmosphere that they are given a supply of pure oxygen. This can be done with a mask or a nasal tube or by oxygenating a plastic tent.

Regardless of the method, it is important to realize that the oxygen must be humidified and the temperature must be controlled to complement the weakened human system.[4] Since pure oxygen enhances combustion, it is necessary to insure that the heating device is designed to protect against oxygen fire hazards.

POLLUTANTS

The air of numerous localities contains hundreds of substances that cause discomfort, illness, and, sometimes, death.[39] Histologic study of inflated lungs has demonstrated rupture of the walls of the alveoli and relaxation of the alveolar ducts about deposits of soot trapped in the parenchyma, as the initial lesion in chronic emphysema.[40] Postoperative tetanus and gas gangrene have been attributed to bacteria sucked into the ventilating system from manured lawns.

Ventilation with outside air, therefore, is often undesirable.