An Inhalational Therapy Service

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THE need for inhalational therapy is more generally recognized than heretofore. At one time, marked cyanosis was considered the only indication for inhalational therapy. Today, alert physicians, believing that oxygen want and inadequate respiratory exchange are harmful and should be remedied, seek out subclinical hypoxia or early respiratory depression and initiate inhalational therapy. Yet, in spite of the fact that there is greater appreciation of the value of inhalational therapy, it is still not used often enough nor sufficiently well.

Even though a physician may have recognized the need for oxygen in hypoxia or the necessity to improve ventilation in instances of carbon dioxide retention, the patient may still fail to be benefited because of one or a combination of the following factors:

(1) The physician may not be sufficiently familiar with the many methods of inhalational therapy. He may request that oxygen be given by nasal catheter, mask or by tent, but he may not understand clearly the characteristics of the various types of equipment and their indications. Ventilators are almost a complete mystery to the majority of physicians, and of those that do work with them, few are familiar with the relative merits of the various means employed for artificial ventilation, of their weaknesses and of their true indications.

(2) The number and variety of inhalational therapy equipment may be inadequate in the institution in which the patient is cared for. The various indications for inhalational therapy, even in the smallest of our hospitals, are many in the course of a year. A great variety of apparatus is required. As a result all the indications cannot be properly met because of insufficient means.

(3) The people who care for the tools of inhalational therapy and administer treatment may not have sufficient knowledge. Because of the mechanical nature of the equipment, attention to detail in the assembly and care of the apparatus is necessary to have it function well. Perhaps the greatest of the causes for inadequate treatment is the lack of understanding of those who administer the therapy. Administration of inhalational therapy is often the responsibility of the nurse who happens to be on duty. In most instances nurses know of the therapy only by having been taught it by other nurses. This is usually inadequate, and even were it modestly adequate the pressures of nursing are such that the administration of inhalational therapy is but a small part of the responsibility of the nurse on duty. The taking and recording of temperatures, distribution and administration of medications, the bodily care of the ill and a multitude of duties which to the nurse are more closely akin to nursing, result in neglect of inhalational therapy. The situation is often aggravated since there is no medical supervision over the therapy, either because of lack of knowledge or of interest.

With the situation as it exists, what can be done so that more patients will receive inhalational therapy and that properly administered? Who should be interested in taking action to further the advantages of inhalational therapy? All physicians who recognize the value and the need for inhalational therapy should assume a responsibility for its improvement. I believe it to be the responsibility of the anesthesiologist more than that of any other physician. This is for many reasons. The anesthesiologist recognizes the need for oxygen and the hazard of carbon dioxide retention. Further, he is, or should be, thoroughly familiar with the mechanics and details of respiratory aids, especially the various means for ventilation. In addition, he is more likely to be available when needed than are other physicians.

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It follows, then, that for the improvement of inhalational therapy several things must be accomplished. Physicians should be educated in the need for inhalational therapy and in the means and methods whereby inhalational therapy may be administered. The symposium which appears in this issue of ANESTHESIOLOGY is recognition of the need for this form of education. At the 1962 meeting of the American Medical Association certain aspects of inhalational therapy were stressed. With education of the physician to the needs of inhalational therapy and of its methods, it will then become possible for the physician to request the therapy he desires for the patient in specific terms. He may then order as he now does medication. He may request, for example, "oxygen by O.E.M. mask, 40 per cent concentration," or "assisted ventilation, to 15 cm. of water with 50 per cent oxygen."

Heretofore, appliances employed in inhalation therapy were cared for on a hit-or-miss basis. Orderlies, night watchmen or whoever was available would pick up the equipment, bring it to the patient's bedside and there deposit it.

Because of the need to assemble carefully and to properly apply inhalational therapy equipment, and the need to have such therapy available on a twenty-four-hour basis, it is necessary that a team of qualified individuals be organized as an inhalational therapy service. It is mandatory that someone should be in charge of this division. I believe the one who should be in charge is the anesthesiologist, for the reasons given earlier. He should assume the responsibility for this service as he does for the supervision of the recovery room. It is, however, not necessary that the physician in charge of inhalational therapy be an anesthesiologist. He may well be an internist. Whoever the individual in charge of the inhalation therapy service may be, it should go without saying that he should be well grounded in medicine, have knowledge of normal and disturbed respiration and be familiar with the equipment used for inhalation therapy.

If recognition of the need for inhalational therapy is followed by improved knowledge of the means of its administration, and if anesrightful responsibility for supervision of inhalational therapy, then the large problems in establishing a service for this type of therapy will, in the main, have been solved. What remains is the development of properly trained individuals to care for the equipment and to administer the therapy. This is not easy, for inhalational therapy is an exacting procedure. Proper therapy cannot be fully achieved unless every detail from proper cleansing, assembly and application of the apparatus to careful analysis of the gas mixture is carried out.

In most institutions the orderly had been asked to deliver cylinders of compressed oxygen to the bedside. As an outgrowth he had been asked also to care for the equipment, assemble it and bring it along with the cylinders of compressed gas to the bedside. This, in general, is unsatisfactory. In an attempt to improve the care of the equipment, and to better organize charges for its use, the care and distribution of inhalational therapy equipment has often become the responsibility of the central supply department. This has resulted in some improvement; it is, however, not the best nor the final answer.

Recently, nurses, nurse anesthetists, laboratory technicians and some orderlies have demonstrated a desire for improved knowledge in this field, and for increased stature and recognition of their endeavor. It was recognized by physicians that this should be encouraged, for such individuals fill a serious void in inhalational therapy. Representatives of the American College of Chest Physicians and of the American Society of Anesthesiologists, by joint action, formed an advisory committee to assist the therapists in organizing themselves in proper fashion, to establish ethical goals, to develop an educational program and to start a journal. Thus, the American Association of Inhalation Therapists was formed. Schools of inhalational therapy were established and curricula laid out. This has progressed in excellent fashion. Recently the American Registry of Inhalation Therapists was established. Candidates who have successfully passed a qualifying examination have become eligible for this Registry. Ethical goals, educational endeavors, standards of practice and qualifications are established by members of the Ameri-

the physicians representing the American Society of Anesthesiologists and the American College of Chest Physicians. Inhalation therapists are growing in numbers and knowledge. Their growth should be encouraged and supported by physicians interested in inhalational therapy.

The Therapist

The number of therapists in an institution will depend upon the size of the hospital, the frequency and type of therapy ordered. In the smallest hospital there should be at least two or three nurses especially trained to administer inhalational therapy. As the size of the institution grows, so should the number of therapists needed. If more than two or three are required, one should serve as the chief therapist. It would then become his responsibility to direct the other technicians. He should be in daily communication with the supervising physician, and should report to him all problems, medical or technical. It should be his responsibility to arrange for coverage on the service. He should supervise the storage, care, handling of apparatus, its proper assembly, transport and the therapy. The departmental inventory, records of maintenance, of therapy and proper completion of charge slips are his responsibility.

Distribution of Equipment

Every nursing unit should have means to deliver oxygen therapy or to produce pulmonary ventilation in an emergency. It should not be necessary to send to central services or to some other unit for equipment which may be life-saving only if it can be applied without delay. Just as nursing units should have airways and suction apparatus at all times, so should there always be oxygen available and the proper means to administer it by some simple method as by nasal catheter. Devices for the production of artificial ventilation such as the Ambu unit should be at hand.

Other apparatus such as IPPB, respirators, and humidifiers may be stored in a central area. Access to this area should be available at all times. In smaller hospitals, without an organized inhalational therapy department, inhalational therapy equipment may be distributed from a central supply department. In each instance the one responsible for the care, handling and transport of equipment should have been taught the fundamentals of its care. No matter how small the hospital, specific individuals should be assigned the responsibility of handling and storage of compressed gases. Cylinders of gases should be stored and handled as recommended in the National Board of Fire Underwriters Bulletin No. 565.°

In large hospitals, where the need is great, it is proper to store the equipment in areas especially reserved for this purpose. Here the apparatus should be cleansed, stored and assembled. The therapist should have a desk and files here and should be able to be reached by phone. He should store spare parts, catalogs, records and inventory here. In some hospitals respirators may be stored and cared for in other areas, such as on a respiratory unit.

Compressed oxygen is necessary for inhalational therapy. All modern hospitals should have oxygen and suction piped to the patient's bedside. This eliminates the bother, labor and delay associated with transport of compressed gas cylinders to the bedside. Piped oxygen, though originally costly, is economical in the long run for it eliminates to a large extent the expense and inconvenience of reducing valves. Oxygen in piped systems is of sufficiently low pressure to be used directly with a flowmeter.

Records

A certain minimum of records must be kept.

(1) *Request Form.* On this form the physician records, either in writing or by use of a check-list, the exact type of therapy he wishes to be employed upon his patient, such as catheter, mask, or IPPB; what the concentration should be, the desired humidification, type of aerosol, etc.

(2) *Inhalation Therapy Record.* This should be kept in duplicate. One copy remains with the patient's chart and the other is sent to the inhalational therapy department upon completion of treatment and there filed. Upon

° May be obtained from the National Board of Fire Underwriters, 85 John Street, New York 38, New York.

this form should be recorded the patient's name, name of physician in charge, date therapy was started, diagnosis, type of therapy ordered and type of therapy applied, by whom and at what time, oxygen flow and concentration, type and concentration of aerosol, degree of pressure required, and any other pertinent data. Comments by the technician are recorded as to any complications or difficulties which may have arisen with use of the apparatus.

(3) *Daily Log.* A log book is kept in the inhalation therapy department and used as a basis for rounds. Hereon may be recorded such data as mode of therapy, duration, results, etc.

(4) *Inventory Chart.* This record, in tabular form, notes numbers of apparatus and of what particular type and how many are at hand, in use or away for repair.

(5) *Charge Slips.* When completed these denote type of therapy, hours or days of use and the charge per day or per unit. One copy is forwarded to the administration and one copy kept on file.

Charts and Forms

There are certain types of prepared material which may be of value and advantageous in the care of patients:

(1) Table of weights, pressure and contents of various-sized cylinders.

(2) Hours of use at various flow rates from cylinders partly filled.

(3) Detailed procedure forms for each type of apparatus related to its assembly, application and cleansing.

(4) Percentage concentration to be expected at various flows of oxygen with various types of equipment.

(5) Supply of signs warning against smoking, use of flames, electrical appliances, etc.

Cleansing

In general all apparatus should be cleansed with soap and water or mild detergents. All apparatus which has been in contact with patients should be either disposable, or if to be used again, sterilized by boiling or by gas sterilization. Nasal catheters, if they are of the plastic type, should be discarded. If of the rubber type they may be boiled. Rubber face masks should be soaked in a mild detergent, thoroughly washed and dried. The air filters in oxygen tents should be cleaned. The tent covering should be discarded if disposable; if not, it should be thoroughly washed with a mild detergent and hung up to dry. Incubators should be thoroughly scrubbed with mild detergents and allowed to dry. Further suggestions may be found in the chapter, Asepsis for Inhalational Therapy, in this symposium.

Equipment

Inhalational therapy equipment may be divided into several groups: (1) apparatus to deliver a higher than normal concentration of oxygen for the treatment of hypoxia, (2) devices, the prime purpose of which is to improve pulmonary ventilation, and (3) equipment designed to deliver aerosols to the pulmonary tree. Often two or more of these therapeutic endeavors can be accomplished by a single apparatus.

Apparatus to Improve Oxygenation (without altering intrapulmonary pressure)

Nasal Catheter. Perhaps the simplest and most universally employed means of inhalation therapy is the use of the nasal catheter. This method is by far the best method considering the simplicity of apparatus, minimum of care required, and effectiveness. An important disadvantage is that it is uncomfortable to some patients. One should always employ a well lubricated green-colored catheter for purposes of identification. I prefer one made of rubber.

Bag and Mask. There are two general types of bag and mask apparatus; one in which the gas is delivered into a bag connected directly, without a valve, to the mask, and the other in which there is a valve interposed between the bag and the mask. The function of the valve in the latter is to prevent rebreathing. Rebreathing, with its associated carbon dioxide retention, is an important consideration in the administration of inhalational therapy to sick patients. In employing bag and mask systems, when there is no valve between the bag and the mask, the bag is usually small and collapses upon inspiration. The additional tidal exchange is met through inspira-

tory valves. Such valves are usually too small and cause resistance to gas flow. When there is a valve interposed between the bag and the mask it is important to remember that the delivery of fresh gases into the bag should be sufficiently great so as to prevent the bag from collapsing at the end of inspiration. This is usually done by an air injector system wherein the volume of oxygen-air into the bag is large. There is an inspiratory spill valve incorporated at the mask end so that if the bag does collapse air can be inspired. The expiratory valve in this latter group of bag and mask systems is usually satisfactory.

There are a large number of disposable plastic face pieces and bag and masks. In general, these are to be used only when moderate amounts of elevated oxygen percentage are to be employed, and are ordinarily inadequate to provide satisfactory concentrations to the seriously ill patient. The better disposable masks have an inspiratory and expiratory valve incorporated directly into the mask.

Nasal Cannula. This is, in my opinion, a poor method for giving oxygen. Nasal cannulae cannot be depended upon for they become almost valueless in the presence of nasal obstruction or mouth breathing. Only under ideal circumstances can alveolar oxygen concentration be elevated. The method is unreliable and there are better and more dependable means.

Oxygen Tent. In general, this apparatus is unsatisfactory for the administration of high oxygen concentrations. To obtain suitable oxygen levels for a patient in an oxygen tent it is important that the nursing attendance be almost constant. One must carefully tuck the canopy under the sheets to insure a tight fit. It is necessary that large flows be delivered to compensate for leaks. Even if this were accomplished an undesirable characteristic of an oxygen tent is the requirement to open the tent to care for the patient. This results in marked fluctuations in oxygen concentration. These changes in oxygen concentration are poorly tolerated by the ill patient. There are, however, some circumstances in which an oxygen tent might be valuable. Tents may be satisfactory for dehumidification, for maintaining an air-conditioned, cool atmosphere, and for a pollen-free atmosphere. As a means for administering oxygen to seriously ill patients its role is questionable.

Head Hoods. These are primarily designed to be placed around the patient's head. As such they are only fairly satisfactory because they require fixing the plastic collar about the neck. A hood such as a Burgess Box, designed originally for the administration of oxygen to adults, is best as an apparatus for administering high oxygen concentrations to children. The plastic part is snugged about the youngster's abdomen, and the upper extremity, arms and head can thus be in a high oxygen atmosphere. It is possible to feed, bathe and care for the child through the open top of the hood. The apparatus can serve as a dehumidification or cooling unit with the proper application of ice.

In choosing apparatus which will be employed to improve oxygenation, it is proper to place greatest reliance on nasal catheter administration and on the use of a nonrebreathing bag and mask apparatus. Nasal catheter administration requires careful placement and daily changing. To obtain satisfactory results with the bag and mask constant attention should be paid to the tightness of fit.

Whatever the apparatus employed, once applied its use should be continuous. Intermittent oxygen administration is not satisfactory nor practical.

Apparatus to Improve Ventilation

Carbon dioxide retention and oxygen want often go hand-in-hand. It is thus apparent that, under some circumstances, the administration of oxygen alone in respiratory distress may not be enough. Improvement may depend upon increase in respiratory exchange. This is best accomplished by intermittent positive pressure. There are many forms of intermittent positive pressure breathing apparatus employed to improve ventilation, and the choice of pressure breathing apparatus to service an institution is not easily accomplished. There are many parameters to consider in the choice of such devices. There is no single apparatus which will satisfy all requirements. One must remember that, in general, the patients upon whom such apparatus may be employed may suffer from pulmonary disease, pulmonary infections and

oxygen want. They may thus be subject to hypopnea as a result of attempts to improve oxygenation or ventilation. It is apparent, then, that pressure breathing devices employed in such individuals should have either or both of the following characteristics. First, they should have an incorporated air diluter system, so that control may be exerted over the oxygen percentage delivered to the patient. Second, inasmuch as hypopnea or apnea may develop, pressure breathing devices employed in such patients should be able to ventilate patients on a controlled respiration basis.

Pressure breathing apparatus is often used for aerosol administration to patients in chronic hypoxia. A pressure breathing apparatus with an incorporated air diluter system must also be used here, with properly designed nebulizers. Most pressure breathing devices on the market are satisfactory for the above, for aerosol administration is usually intermittent.

It is when pressure breathing devices are to be employed for continued ventilation that it becomes necessary to consider the characterisitcs of pressure breathing devices further. If apparatus is to be used on a demand or assister basis on patients suffering from oxygen want, it is necessary that, in addition to its having an air diluter mechanism, it should be sufficiently sensitive to respond to minimal degrees of negative pressure produced by the patient's inspiratory efforts to initiate gas flow. It should produce a satisfactory pressure pattern and the resulting mean pressure should be low. There are many apparatus which meet the need for low sensitivity, but very few which are properly designed to produce satisfactory pressure patterns on conscious patients (see chapters on automatic lung ventilators in this symposium).

The problem of obtaining apparatus to meet the further requirements of maintaining continued artificial respiration, as in controlled respiration, has been better resolved. A few of the apparatus used as assisters in inhalational therapy may serve well also for controlled respiration. By far and large, however, the best type of intermittent positive pressure breathing apparatus for continued artificial ventilation is that designed primarily for the administration of anesthesia. It is possible to use such apparatus directly on a patient, rather than through an anesthesia apparatus. In the past years there has been a marked improvement in the development of such apparatus for anesthesia, and advantage should be taken of them for their use in artificial ventilation. An important change in some of these apparatus is that, though basically pressure-cycled, they have been redesigned to serve as volume-limited ventilators in some of their characteristics. Greater attention has been paid to the control of the pressure pattern such apparatus produce. In the better ones it is possible to control the time ratios of inspiration, expiration and respiratory pause. It is obvious that those who employ these apparatus on patients should recognize the need for control of the variables. If one can control duration of inspiration, expiration, respiratory pause and degree of pressure delivered, then one can maintain artificial ventilation on these patients for longer periods of time with greater safety.

It should be said further that decreasing reliance is placed upon the negative phase of the positive-negative type of respiration, even in patients with expiratory flow problems in whom it had once been recommended, and in patients with hypotension in whom it had had also been recommended. It is generally recognized that the best type of pressure breathing is that by intermittent positive pressure, properly administered.

A valuable pressure breathing device which may play a role in hospital use is the Ambu. With this one may administer intermittent positive pressure breathing for resuscitation very satisfactorily. The apparatus consists of a nonrebreathing bag and mask system, with a self-inflating bag which sucks air in, or to which oxygen may be added.

Expiratory positive pressure has been recommended for the treatment of pulmonary edema. This may be accomplished by a relatively simple apparatus employing a bag and mask wherein the patient's exhalations pass through narrowed orifices.

There are pressure breathing devices employed for long-term ventilation such as a tank respirator, or for intermittent use, as with the cuirass type. On occasion it is difficult to

maintain position of a mask or to ventilate through a tracheostomy tube for long periods of time, and there are in many instances patients with muscular paralyses who would do better in such apparatus as the cuirass or tank ventilator.

Equipment Needed for an Inhalational Therapy Unit

The character and number of various types of apparatus is dependent upon the variety and number of diseases treated in a given institution, plus an amount to serve as reserve or for emergency use. There is no set rule, and experience will dictate the final amount.

The following should be considered as a minimum number of apparatus in an active general hospital of 150 beds. The examples given may be replaced by others as good:

- 12 Two-stage reducing valves (not necessary if there is a piped oxygen system)
- 18 Flowmeters (Thorpe-tube type, back pressure compensated)
- 18 Humidifier bottles
- 2 High humidity vaporizers
- 48 Nasopharyngeal catheters (colored green, plastic or rubber)
- 24 Disposable face tents
- 24 Disposable face masks with inspiratory and expiratory valves
- 2 Burgess open top boxes for infants or children
- 6 Nonrebreathing masks and bags (O.E.M. type with diluter mechanism attachment)
- 2 Expiratory positive pressure masks and bags (O.E.M. type with diluter mechanism attachment)
- 1 Combination assister and cycling ventilator (mask type with diluter mechanism for ventilation and/or aerosol therapy.)
- 1 Heated nebulizer apparatus
- 1 Cycling ventilator (anesthesia type)
- 1 Body respirator with appropriate collars, or cuirass type
- 1 Incubator
- 1 Infant ventilator (Kreiselman or Flagg type)
- 2 Bag and mask ventilators (Ambu type)
- 1 Set tracheostomy adapters (Livingston or plastic type)
- 24 Suction catheters (calibrated in centimeters, Davol type)
- 12 Glass "Y" tubes for suction
- 1 Oxygen analyzer (Beckman type)
- 1 Ventilation meter (Monaghan or Wright type)

Summary

There are three requisites for effective inhalational therapy:

(1) Physicians should be acquainted with the various methods of administering inhalational therapy, for only through such knowledge can they request therapy in specific terms. (2) Technicians, especially trained to administer inhalational therapy and to care for its equipment, should be always under the immediate supervision of a physician familiar with inhalational therapy in all its forms. (3) Inhalational therapy should be administered by a service of its own, with its own space. The service should be responsible for its own inventory and maintenance of records. Inhalational therapy is a valuable adjuvant of medical care and the above are essential if we are to improve the treatment of hypoxia and hypopnea.