Therapeutic Aspects of Pulmonary Emphysema*

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The emphysema patient who suffers a bronchospastic crisis represents one of the most trying situations with which we, as physicians interested in chest diseases, are confronted. The allergic approach in most patients with pulmonary emphysema has proved to be so disappointing generally that many physicians are inclined to omit completely a serious evaluation of allergenic possibilities. Certainly even the partial conquest of the allergic bronchospastic component is cogent and a careful survey for potentially significant extrinsic offenders followed by desensitization may be fruitful in a small percentage of patients.

It is always important to bear in mind that people with emphysema have physiological derangements which are seriously compromised secondary to superimposed bronchospastic difficulties. Therefore, a few cardinal principles are worthy of review:

1) Adequate gas exchange, which takes place at the alveolar level, requires effective alveolar ventilation. There is an enormous quantitative difference between two individuals, each exhibiting a minute volume of 10 liters per minute—one of whom has a tidal air of 500 cc. who breathes 20 times per minute, and the other who breathes 40 times a minute with a tidal air of 250 cc. The significant difference lies in the consideration of the anatomical dead air space, which ordinarily is approximately 150 cc. for adult males. Effective alveolar ventilation in the first instance would be 500-150 cc. (the volume of the anatomical dead air space) or 350 times 20 breaths per minute, which equals 7000 cc. per minute; whereas in the second case we would have 250-150 cc. times 40 breaths per minute, which equals 4000 cc. per minute. Obviously there is a tremendous quantitative difference between 4000 and 7000 cc. of effective ventilation per minute. Based on this consideration, tracheotomy may be indicated in desperate situations, the purpose of tracheotomy being to diminish the volume of the anatomical dead air space as well as for suctioning secretions in such cases.

2) Many emphysema patients already exhibit varying degrees of diminished arterial oxygen saturation with or without an increase in the partial pressure of carbon dioxide in the arterial blood. The net effect of superimposed bronchospastic difficulties is to aggravate the existing degree of lowered arterial oxygen saturation and hypercapnia by diminishing further the ingress of oxygen and the egress of carbon dioxide. This circumstance is referred to as alveolar hypoventilation.

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3) When one speaks of diminished arterial oxygen saturation, there is the additional problem of alveolo-capillary block. The syndrome of alveolo-capillary block is not merely a manifestation of thickening of the alveolar membrane, but embraces the problem of diminished total functioning alveolar membrane available for gas exchange. The presence of any type of fluid within the alveolus which interferes with effective gas exchange is part and parcel of the alveolo-capillary block syndrome.

Apropos the discussion at hand, there is no question but that disruption of normal alveoli leads to diminished surface area available for gas exchange. Furthermore, asthmatic difficulties are frequently attended by an increase in mucus secretion which aggravates the existing degree of alveolo-capillary block. Add to this complex atelectasis secondary to inspissated mucus and one has a further increase in the venous admixture returning to the left side of the heart over and above any pre-existing level.

4) Anxiety commonly increases the degree of pre-existing bronchospasm.

5) Fever, which may be due to drug reaction, bronchial or pulmonary infection, at times associated with atelectasis, increases the tissue requirements for oxygen, which are already compromised. The work of breathing is also increased.

6) But hanging like the Sword of Damocles over this whole array of happenings is the spectre of hypoxia in the emphysematous patient. Courmand and other workers have demonstrated that even moderate degrees of anoxia have a constrictive effect on the pulmonary vascular bed, which results promptly in the development of pulmonary hypertension. This of course imposes a strain on the right ventricle which may result in right heart failure. Anoxia and cor pulmonale are frequently responsible for the development of polycythemia and hypervolemia, which in turn invoke an additional burden on the circulation, enhancing the pre-existing degree of right ventricular strain.  

It now becomes obvious that a respiratory complication in the emphysematous individual increases the work of breathing, it reduces alveolar ventilation below pre-existing levels, it may increase the degree of alveolo-capillary block, it may increase the venous admixture returning to the left side of the heart, it may decrease arterial oxygen saturation and increase the degree of hypercapnia—all resulting in ingravescent pulmonary hypertension and in a potential breakdown of compensatory mechanisms preserving the maintenance of a normal pH.

At this point, we shall apply some of these principles to the medical management of the emphysema patient with super-imposed bronchospastic difficulties. Several DON'Ts are in order:

1) Don't use morphine and atropine. This point cannot be over-emphasized. Morphine is a broncho-constrictor and atropine dries pulmonary secretions. Furthermore, morphine, which depresses the central nervous system, specifically dulls the respiratory center. There are those who use meperidine (Demerol) sparingly. Chloral hydrate is effective as a sedative but it must also be used with caution.
2) Don’t abuse oxygen. In advanced pulmonary emphysema the level of hypercapnia may be so great that the respiratory center no longer responds adequately to increases of carbon dioxide in the blood. Oxygen therapy may result in decreased ventilation, which increases carbon dioxide retention. This may rapidly lead to a breakdown of the acid-base relationship, which eventuates in uncompensated respiratory acidosis and its grave sequelae. This doesn’t mean that oxygen is contraindicated in the treatment of pulmonary emphysema, but it does indicate that oxygen should be used with caution and under careful supervision by physicians and nurses who are acquainted with the hazards of oxygen therapy in the emphysema patient.

3) Above all, don’t palliate in the face of a desperate situation. Time is of the essence and a positive approach utilizing sound measures simultaneously may be mandatory.

Therapeutic approach to the patient with pulmonary emphysema and superimposed bronchospasm:

1) Bronchodilators such as isopropyl ephedrine (Isuprel) and racemic epinephrine hydrochloride (Vaponephrin) are of value in improving alveolar ventilation and thereby promoting carbon dioxide elimination. Since cholinergic impulses exert a bronchospastic effect, it is logical that anticholinergic drugs be considered. Good spasmolytic effect without side reaction has been reported by Segal,2 Seabury3 and others. They have used Methscopolamine bromide (Pamine) as an aerosol in doses of 0.22 and 0.33 mgs. per cc. Barach recently reported using diphenmethanil methylsulfate (Prantal) by injection with measured improvement of ventilation.4 It is well to familiarize oneself with these approaches since some patients appear to become refractory to sympathomimetic agents. Aminophyllin given intravenously is a dependable bronchodilator.

2) Oxyethylated tertiary octylphenol-formaldehyde polymer (Alevaire) is frequently used to decrease the viscosity of bronchial secretions. Although this preparation may be used effectively, some patients exhibit an increase in the degree of bronchospasm while receiving this form of therapy. Secretory expectorants should be used routinely. Where potassium iodide is poorly tolerated, one may use a guacolate preparation.

3) The graver the problem, the greater the indication for the use of antimicrobial therapy even prior to the availability of culture and sensitivity reports. Adjustments may be made within 24 hours if necessary. We include nitrofurantoin (Furadantin) in the group of drugs to be used for sensitivity determination, particularly when secretions are obviously purulent. Furadantin may be quite effective in the presence of pseudomonas infection. Many physicians utilize antibiotic aerosols while others prefer the conventional methods of drug administration.

4) Much has been written during the past several years concerning the virtues of intermittent positive pressure breathing in the management of pulmonary emphysema. To be most effective this should be combined with bronchodilator aerosols. Apparatus, which incorporates positive pressure breathing with exsufflation and high negative expiratory pressure,
would appear to have some advantage in some cases over the usual form of IPPB/I. At the appropriate time diaphragmatic breathing exercises may be helpful in improving pulmonary ventilation. Apparently, patients learn the technique reasonably well if they are tilted slightly in the head-down position with a sand bag applied to the abdomen.

5) Although ACTH and Cortisone have been used effectively in many instances, the hazards incurred with these agents are well known to all. The advent of metacortandracin (Meticorten) has broadened the possibilities of steroid therapy because this preparation does not cause sodium and fluid retention or potassium depletion. Barach\(^4\) has reported favorable results which have been confirmed by other observers. The average initial dose is approximately 50 mg. daily for one to three days until symptomatic improvement occurs. Thereafter the dose may be halved and a maintenance dose of 10 to 20 mg. daily continued. Since upper gastrointestinal tract ulceration and/or perforation are not uncommonly encountered among patients taking Meticorten\(^5\) it has been suggested that all patients on this preparation be given the benefit of intermediary feedings and antacid preparations routinely.

6) The more seriously ill the patient, the greater the need for caution in the amount and frequency of sedation administered, particularly if coupled with oxygen therapy. We have already stated that oxygen is indicated in the hypoxic patient. In general it is advisable to begin with lesser amounts of oxygen, preferably one liter per minute by nasal catheter increasing the rate of flow by increments of one liter at intervals of 12 to 24 hours as indicated until a maximum of seven liters is attained. At the appropriate time, patients should be weaned away from oxygen over a period of several days.

7) Those who are in congestive heart failure should be treated with digitalis and other measures as required. The proper place of acetazolamide (Diamox) as a therapeutic agent in this condition is still not clear.

8) Venesection is indicated whenever the hematocrit exceeds a level of 52 per cent. Venesection reduces the blood volume and the degree of polycythemia.

9) Pneumoperitoneum still has its advocates and its detractors. There can be no doubt that it has been beneficial in a certain percentage of patients suffering with pulmonary emphysema. Perhaps those who have had broad experience utilizing this measure properly in a large sample of patients have more cause for enthusiasm than others. It must be borne in mind that the volume of air per refill and the frequency of refills are quite different here than for the tuberculous patient. The objective of pneumoperitoneum is to introduce only sufficient air to permit the diaphragm to enter again into the mechanical ventilatory process. Barach has indicated that an elevation of two inches suffices.\(^6\) Excessive amounts of air impede ventilation.

At this juncture I should like to speculate for a moment. Anatomically the diaphragm is a musculo-tendinous structure. Even normally, we un-
understand that the proportion of muscle and tendon varies considerably. The muscular component is striated muscle which complies with the law of stretch-hypertrophy. Conversely, the muscle fibers may well atrophy with disuse. Is it not conceivable then that disuse atrophy of the diaphragm secondary to long-standing pulmonary over-distention could be reversible or irreversible? Might that not explain, at least in part, why some patients benefit from pneumoperitoneum and some do not? Then again, the success or failure of pneumoperitoneum therapy may possibly be related to lung compliance. A rigid lung may not respond to pneumoperitoneum whereas a supple lung may. I have observed patients whose diaphragm following the first insufflation of air appeared flaccid and ineffectual, but who some weeks later exhibited strong diaphragmatic contractions. In my experience these are the patients who have derived substantial benefit from pneumoperitoneum.

10) The induction of the hypometabolic state in the advanced, crippled pulmonary patient using radio-active iodine has been intriguing. My personal experience with this approach is too limited to be worthy of mention today. Certainly the principle of decreasing the tissue demand for oxygen in the face of an already compromised supply is quite as reasonable here as in the case of the cardiac cripple. Radio-active iodine will prove to be no panacea but may be of some benefit in a highly selected small percentage of patients with advanced pulmonary emphysema. This form of therapy is not a substitute for measures discussed previously.

SUMMARY

1. Some of the important physiological aberrations in severe pulmonary emphysema are reviewed. The cumulative effect of these defects frequently results in complications involving the cardio-vascular system.

2. The abuse of sedatives, narcotics and oxygen therapy is emphasized. Their relationship to the potentiality of inducing uncompensated respiratory acidosis is stressed.

3. A positive approach to therapy is presented—bronchodilators, secretory expectorants, detergents, antimicrobial therapy, pressure breathing, breathing exercises, steroid therapy, venesection, pneumoperitoneum and radio-active iodine.

RESUMEN

1. Se revisan algunas de las más importantes aberraciones fisiológicas del enfisema pulmonar. El efecto acumulativo de estos defectos, frecuentemente resultan en complicaciones cardiovasculares.

2. El abuso de sedantes, narcóticos y oxígeno terapia se destaca. Su relación con la posibilidad de producir acidosis respiratoria descompensada se recalca.

3. Se presenta un modo de ataque positivo del problema mediante el uso de bronquiodilatadores, expectorantes secretorios, detergentes, respiración a presión positiva, ejercicios respiratorios, terapia con esteroides, oxigenoterapia, vangrías, neumoperitoneo y yodo radioactivo.
RESUME

L'auteur passe en revue quelques-unes des importantes anomalies physiologiques qui surviennent dans l' emphysème pulmonaire. L'effet cumulatif de ces altérations entraîne fréquemment des complications qui atteignent le système cardio-vasculaire.

L'auteur insiste sur le rôle de l'abus des sédatifs, des narcotiques et de l'oxygénotherapie. Il insiste sur le fait qu'ils peuvent être à l'origine d'une acidose respiratoire irréversible.

L'auteur présente un essai positif de traitement: par les bronchodilatateurs, les produits qui facilitent l'expectoration des sécrétions, l'exercice respiratoire, la thérapeutique par les stéroïdes, l'oxygénotherapie, la saignée, le pneumopéritoine et l'iode radioactif.

ZUSAMMENFASSUNG


3. Eine positive Stellungnahme zur Therapie wird vorgelegt—Bronchodilatatoren, Expektorantien, Abführmittel, antimikrobielle Behandlung, Druckatmung, Atemübungen, Steroid-Behandlung, Aderlass, Pneumoperitoneum und radioaktives Jod.

REFERENCES


