A Method of Continuous or Intermittent Tracheobronchial and Pulmonary Infusion*

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In the course of investigations or treatment of bronchopulmonary disease it is often desirable to introduce agents directly into the bronchial tree. In humans this can be done by several methods. The most efficient non-surgical method is by bronchoscopy, and in this respect the authors of a recent publication utilize this procedure to introduce medicated lyophilized oil into tuberculous lesions.¹ Another similar method utilizes a soft rubber catheter introduced into the trachea under fluoroscopic control. This is essentially the method frequently used for instillation of radio-opaque material into the tracheo-bronchial tree, for bronchography. Any of the other methods used for bronchography, such as the supraglottic drip or the trans-tracheal method, may be used similarly for the introduction of medications into the bronchi.

The disadvantage of all these methods is that they are cumbersome and entail a great deal of co-operation on the part of the patient. They are also very ill suited for continuous therapy or for therapy requiring frequent instillations into the bronchi every few hours or daily.

For this reason the use of aerosol solutions, either with or without intermittent positive pressure breathing, has become widely accepted. The limitations of these methods are several. One is again patient co-operation, since the patient must be taught how to use the apparatus efficiently. Another is the amount of medication which can be introduced in this manner. Even discounting the quantities of material which may settle on buccal mucosa and pharynx and cause irritation in these areas, the amount which reaches the tracheo-bronchial mucosa is necessarily small and usually consists of about 1 cc. of solution three or four times a day — a considerable portion of which never reaches its intended destination.

The most efficient method would, of course, be tracheotomy, for with this, solutions to any amounts tolerated by the tracheo-bronchial tree could be introduced as desired throughout the day. Suction could be applied when necessary to remove unwanted secretions. The tolerance of the tracheo-bronchial tree for large quantities of fluid is remarkable. Nevertheless, even though tracheotomy is becoming more widespread and acceptable than formerly, it is still not favored as a routine method of therapy for the majority of cases.

The tracheal fenestration operation proposed by Rockey⁴ meets some of the objections to most methods, but here again one exposes the patient to a considerable surgical operation and a period of wound healing is necessary which might easily interfere with the administration of certain solutions.

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As with straight tracheotomy, this method would not be desirable where a period of therapy covering only a few days or possibly a few weeks is contemplated.

In order to overcome these objections the author is attempting to introduce materials directly into the tracheo-bronchial tree via a plastic tube. The description of the method follows:

The skin of the neck for a considerable area over the trachea is cleansed and prepared, as for a surgical operation. Local anaesthesia is secured by skin infiltration for 1-2 per cent procaine and the anaesthesia is carried down to the trachea and between two cartilaginous rings into the lumen itself. This method of transtracheal anaesthesia is a standard procedure in many institutions for bronchoscopy and bronchography and is practically devoid of risk.

A No. 14 gauge needle is now inserted through the prepared site into the trachea. Through this a plastic catheter is threaded until about one inch of the catheter is well in to the tracheal lumen. This should prevent the catheter from slipping out of the lumen with neck movements or with cough or swallowing. Some anesthetic is dribbled through the catheter so that its presence will be tolerated by the patient. (An aerosol of anesthetic solution given every three or four hours may also be of some value). The catheter can then be sealed and the seal opened for medication to be administered as often as necessary during the day or else if continuous medication is desirable, it may be connected to an infusion bottle and fluid allowed to enter the catheter at the desired rate for as long a period as may be deemed necessary.

Before any real progress could be made with this method, it would be desirable to find out more about the tolerance of the tracheo-bronchial tree for solutions of all kinds, both as to amount and concentration.
FIGURE 2: Diagram showing method of insertion of catheter into trachea. The dotted lines indicate the portion of the catheter in the tracheal lumen. The loose knot in the catheter and the sutures holding this to the strap muscles of the neck prevent the catheter from slipping out of the lumen with swallowing or with neck movements. The free end of the catheter is brought under the skin to issue on the back of the animal.

Since it would be advisable to test this on animals first, a procedure was drawn up for inserting a similar plastic catheter into the animal trachea. The purpose of this communication is to describe the method as we employ it at present in rabbits, and to suggest the possibilities of the method which we intend to explore. Later publications will deal with results.

The test animal we have selected has been the rabbit. This is a matter of convenience. Rats, mice and guinea pigs are too small, although the method could be used even in these animals. Dogs and cats could also be suitable subjects, but were not available with our present facilities.

The rabbit is first anesthetized with preliminary Nembutal intravenously and then carried on open ether anesthesia. An incision is made in the mid-line of the shaved neck and the trachea indentified.

A small opening is made with a scissors between two tracheal cartilages just below the thyroid gland. This opening is just large enough to allow the plastic catheter (No. 5 French) to be introduced. This is introduced
about an inch into the trachea until its tip is at a level estimated to be just above the carina. A loop is made in the catheter to be introduced.

The catheter with its loop now resting on the trachea is sutured to the strap muscle of the neck (Fig. 2). The loop is of some value in preventing the catheter from being pulled out of the trachea.

The free end of the catheter is then brought under the skin of the animal around to the back, through a stab wound prepared in the shaved back of the animal.

The net result is now a catheter protruding from the back of the animal which is in direct communication with the tracheo-bronchial tree. This could now be used, if necessary, to introduce materials intermittently—in any amounts and at any stated intervals desired.

In order to introduce fluids continuously it was necessary to devise an apparatus which could be sutured firmly to the back of the animal and which would carry a plastic bottle of sufficient size to allow infusion to proceed over several hours.

Several different types of apparatus have been devised. Fig. 3 shows a view of a metal plate which we have used for this purpose. This can be sutured to the animal and the bottle with its catheter attached to the catheter issuing from the animal.

Fig. 4 shows the assembly in place on the animal. Flow can be adjusted at several drops per minute. The rate is adjusted so as not to cause discomfort or coughing. In this way it is assured that the total dose is carried into the tracheo-bronchial tree.

There are numerous possibilities for further investigation with this method. Obviously, as intimated above, the tolerance of the tracheo-bronchial tree for solutions of all kinds can be tested.

Studies of infection of the tracheo-bronchial tree and lungs by introducing standard doses of the infectious agent, such as tubercle bacilli or staphylococci, should be easily accomplished. Studies of response of the infection to various antibiotics or other materials should follow as a natural consequence.

FIGURE 4: This shows the assembly in place and in operation in the intact animal.
The effect of irritants and carcinogens on the bronchial mucosa and the effect of temperature changes on the bronchial mucosa would also seem to be a fruitful source of study.

The carriage of particulate matter or radioactive solutions from the tracheo-bronchial tree and lungs to the draining lymph glands also suggests itself as a possibility for investigative study by this procedure.

SUMMARY

1. It is often desirable to introduce materials into the tracheo-bronchial tree in the course of investigation or treatment of bronchopulmonary diseases.
2. Aerosol methods do not provide sufficient fluid to the bronchi and operative procedures are cumbersome.
3. A method of introducing and leaving a cannula in the tracheas of rabbits has been evolved and is described.
4. With this method, solutions can be introduced directly into the tracheo-bronchial tree in large amounts, either intermittently or continuously for days or weeks at a time.
5. It is proposed to use this method to try the effects of various solutions in the investigation and treatment of normal animals and others with induced diseases of the respiratory tract.
6. The use of this method in the treatment of human disease is suggested.

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RESUMEN

1. A veces es de desearse el introducir materiales dentro del árbol traqueobronquico al investigar las enfermedades broncopulmonares.
2. Los aerosoles no proporcionan suficiente líquido dentro de los bronquios y los procedimientos son molestos.
3. Se ha descrito un método consistente en introducir una cánula en la tráquea de conejos.
4. Por este medio se pueden introducir grandes cantidades de soluciones directamente en el árbol traqueobronquico ya sea intermitente o continuamente por días o semanas.
5. Se propone que se use este método para ensayar varias soluciones en la investigación y tratamiento de animales normales y en animales con enfermedades provocadas en las vías respiratorias.
6. Se segiere la aplicación de este método en el hombre enfermo.

RESUMÉ

1. Il est souvent désirable d'introduire des produits dans l'arbre trachéo-bronchique au cours d'investigations ou de traitement des affections broncho-pulmonaires.
2. Les aérosols n'apportent pas un liquide suffisant aux bronches et les procédés opératoires sont gênants.
3. Une méthode d'introduction et de retrait d'une canule dans la trachée de lapins a été mise au point et est décrite.
4. Avec cette méthode, des solutions peuvent être introduites directement dans l'arbre trachéo-bronchique en grandes quantités soit de façon intermittente, soit de façon continue, pour des jours ou des semaines en une fois.
5. Les auteurs proposent d'utiliser cette méthode pour essayer les effets de différentes solutions pour l'examen et le traitement d'animaux normaux et d'autres porteurs d'affections provoquées de l'arbre respiratoire.
6. L'utilisation de cette méthode dans le traitement des affections humaines est évoquée.

REFERENCES