that the appearance was suggestive of advanced silicosis. The patient died on September 5th, and a necropsy was performed on the next day.

Macroscopical Appearances.

There were dense pleural adhesions on both sides of the chest. The right lung was almost coal-black in colour; small, hard nodules were found along its anterior border and throughout its substance. Several small cavities were present at the apex; they were smooth-walled, and surrounded by dense fibrous tissue. The lung generally was fibrosed, and small scattered areas of broncho-pneumonia were visible. The left lung was voluminous, heavy, and dark grey in colour. Small, hard nodules were present throughout its substance, which was markedly fibrosed. At the apex were several small cavities with thick walls. The rest of the lung was the seat of extensive broncho-pneumonia.

The bronchial glands were enlarged, black in colour, but not very hard. The heart muscle was pale and soft, and the mitral valve was sclerosed and incompetent. The liver was in the condition of chronic passive congestion with fatty change.

Microscopical Appearances.

Both lungs showed the condition of well-marked pneumonoconiosis with extensive areas of fibrosis and obliteration of the smaller bronchi and vessels. There was an excessive amount of dust in the fibrotic areas, and dust cells were present in large numbers throughout the sections. The alveolar walls were fibrosed and thickened, and contained dust deposits and dust cells. Caseation was occurring in some of the fibrotic areas, certain of which showed giant cells and an atypical picture of tuberculosis. In the right lung small areas of broncho-pneumonia were present. The histological appearance of the left lung differed only in degree from that of the right. The fibrosis was more marked, and the broncho-pneumonia, which was undoubtedly of tuberculous origin, was very much more extensive. The bronchial glands showed some fibrosis, and fine dust particles were scattered throughout the sections.

Portions of the lungs were digested with trypsin, and the mineral matter was examined microscopically. In addition to an excessive quantity of fine granular dust, much of which was carbonaceous, large dark angular particles were seen, and also flat mica-like and small transparent crystalline particles of silica or silicates, which ranged in size from the order of the ultra-microscopic to 60 or more microns in length. Some of the mica and crystalline particles were coloured red from the presence of iron. Under the polarizing microscope the mica and silica particles were seen to be doubly refracting. Similar particles were present in the flue dust in which the patient had worked. Sections of both lungs and of the bronchial glands showed, under the polarizing microscope, a large number of doubly refracting particles, presumably silica or silicates.

From the history and the examination of the lungs there can be little doubt but that the pneumonoconiosis preceded the tuberculous infection by many years.

Chemical Considerations.

Chemical analysis of the lungs, boiler scale, and flue dust were made by Mr. T. H. Byrom, F.I.C. The following tables indicate the components in 100 grams of the dried material.

	Left Lung.		Right Lung.	
	Grams.	Percentage of Ash.	Grams.	Percentage of Ash.
Insoluble siliceous matter ...	0.142	3.C3	0.178	3.56
Soluble siliceous matter ...	0.181	3.86	0.156	3.12
Total siliceous matter ...	0.320	6.89	0.334	6.68
Ferric oxide	0.120	2.56	0.450	9.00
Alumina	0.430	9.18	0.430	8.60
Phosphoric anhydride ...	0.380	8.12	0.546	10.92
Calcium oxide	0.017	0.36	0.025	0.50
Magnesium oxide	0.030	0.64	0.042	0.84
Sulphuric anhydride	0.070	1.50	0.073	1.46
Alkalis	3.320	70.75	3.100	62.00
	4.690	100.00	5.000	100.00

	Boiler Scale.	Flue Dust.
	Per cent.	Per cent.
Insoluble siliceous matter	6.40	26.40
Soluble siliceous matter	3.90	6.00
Total siliceous matter	10.30	32.40
Ferric oxide	3.42	27.17
Alumina	1.68	14.12
Calcium sulphate	57.13	21.14
Calcium carbonate	3.60	Trace
Magnesium hydrate	17.80	3.18*
Combined water	4.60	Nil
Carbonaceous matter	1.00	Nil
Phosphoric anhydride	0.074	0.16
		2.5 †

* Magnesium oxide. † Ferrous oxide.

The insoluble siliceous matter in the flue dust contains, in addition to quartz grains, many acicular crystals and flat plates, both transparent and opaque, probably of micaceous and feldspathic origin, derived from the shale and other inorganic material from which the flue dust has been formed. The occupation of boiler cleaner where Lancashire boilers are used includes flue cleaning. The latter is by far the more dusty part of the work, and was undoubtedly the primary cause of the pneumonoconiosis.

It is of interest to note that three boiler cleaners are employed at the particular colliery at which the deceased worked. During the past twelve years twenty-seven men have been employed, and have given up the work; of these, two are known to have died—one the subject of this communication, and another the cause of whose death is unknown. One worked only one day, and another one week. Excluding these four, the average duration of employment was fifteen months. Including the two dead, the average period of work was twenty months. The deceased man had worked the longest period, 113 months, the nearest approaching that time being thirty-six months. There is, however, a man still employed who has been at the work for sixty-two months.

TECHNIQUE IN ENDOTRACHEAL ANAESTHESIA.*

BY

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Not many years ago the administration of an endotracheal anaesthetic was outside the routine of the operating theatre. Its introduction excited such interest as would be accorded to the performance of an unusual or difficult operation. It is not improbable, perhaps, that the procedure was at first regarded as an unnecessary complication. Doubtless also the patience of many a surgeon has been sorely tried on a busy operating day by the first attempts of his anaesthetist.

Within recent years the advantages of the method have become widely known. Surgeons are increasingly anxious to avail themselves of these advantages, and many expert anaesthetists in England now employ the method as a routine for operations which formerly involved many anaesthetic difficulties.

Nevertheless, in some hospitals endotracheal anaesthesia is not available when required; in others, the results compare unfavourably with those obtained by older and more orthodox methods. Since the method can no longer be considered new—and if we grant that it has advantages—it is apparent that there must be some drawbacks to its unqualified employment.

* A paper read in opening a discussion in the Section of Anaesthesia at the Annual Meeting of the British Medical Association, Winnipeg, 1930.

Importance of Intubation Technique.

In modern scientific work some of the most valuable advances have been the outcome of a study of technique. It is my intention to apply this principle to the present subject, and to point out that most of the advantages of endotracheal anaesthesia are available if the anaesthetist will trouble to master the technique of intubation; if he does, the disadvantages become insignificant.

Advantages and Disadvantages.

The veriest novice knows that many of the difficulties in anaesthesia arise from a defective airway. Whatever the cause, the syndrome is familiar—cyanosis, rigidity, laboured respiration—a vicious circle that is a heavy tax on patient, surgeon, and anaesthetist. The ease with which an anaesthetic can be administered through a tracheotomy tube is an obvious contrast.

It may be argued that in many cases such difficulties do not arise, and that in others the error can be rectified by the insertion of a pharyngeal tube of some sort. But such a device cannot prevent obstruction at the larynx, and the anaesthetist must be constantly on his guard against such an occurrence. In operations which do not actually increase the possibility of respiratory obstruction by their nature or situation, most of us are prepared to take the risk.

A free airway can be established as a rule without interfering with the progress of the operation. In those cases, however, in which endotracheal anaesthesia has proved itself most useful, there is no excuse for the anaesthetist who does not establish absolute control of the larynx before the surgeon operates. This control can be secured at once by intubation, with the following results. (1) The airway is free under all conditions. (2) The patient can be protected against the entry of blood into the trachea. (3) Control of the larynx makes it possible to maintain a light and even anaesthesia. (4) The surgeon can be protected from the anaesthetic-laden exhalations of the patient. It is apparent that the provision by intubation of an airway that is practically proof against obstruction is the fundamental principle of the method.

I wish to stress this point. Many of us associate endotracheal anaesthesia with the true insufflation principle as described by Meltzer, Auer, and Elsberg. I hold that with the exception of those operations in which positive pulmonary ventilation is essential to life, low pressure, or no pressure, gives adequate results. Therefore elaborate apparatus is not absolutely necessary in every case. The chief disadvantages are: (1) the risk of possible trauma by the anaesthetist, and (2) the delay involved by intubation. The importance of dexterity in intubation is now obvious, and I propose to give you the results of my own experience.

Position of the Patient's Head.

Some of the chief difficulties which arise during intubation for anaesthetic purposes may be traced to a faulty position of the patient's head. Hyperextension as adopted by some surgeons for bronchoscopy is not only unnecessary in most cases, but actually increases the difficulty of the procedure. The position of the head in relation to the neck and trunk should be the same in the recumbent as in the erect position; this may involve the insertion of a pillow below the occiput. When the position on the table is correct, the cervical vertebrae are in normal relation to the dorsal vertebrae and are not extended. The head itself is slightly extended on the atlas, thus bringing the mandible into a position approximately at right angles to the table. These, in fact, are the relative positions of the air passages instinctively adopted by a man standing in the normal erect position when he scents the air. The natural air passage from nose to glottis is at its freest when such a position is adopted, the nose being the natural human respiratory passage.

Let us consider a mesial section through the head and neck in this position. It is clear that the course of the air passage from nostril to glottis is a curve. A rubber tube with a similar curve, or a catheter mounted on a curved stylet, can be made to follow that course quite naturally, and will enter the glottis in a large percentage of cases; in fact, it will enter the glottis more readily than the oesophagus. If a similar curved tube is passed through the mouth while the head is in the position I have described, it will almost invariably enter the oesophagus.

Intubation can be carried out through the mouth or through the nose, according to the site of the operation. In either case the position of the head is the same.

Intubation through the Mouth.

When the oral route is selected I prefer to pass the tube by direct vision with the aid of a speculum. This instrument should have a wide slot at the side. A self-contained battery in the handle is a convenient means of illumination.

With deep anaesthesia associated with complete muscular relaxation and absence of reflexes in the throat, intubation through the mouth is easily performed. But deep anaesthesia, such as is obtainable with ether, should be avoided if possible. The aim of most of us is to exclude ether, or at any rate to limit its use to a minimum.

When intubating through the mouth under light anaesthesia certain precautions facilitate the procedure and also prevent trauma.

1. Preliminary cocainization of the pharynx and vocal cords with a fine nebulizer is of first importance. This can be carried out before induction, or while induction is in progress. The tendency towards reflex contraction of the pharyngeal muscles on passing the speculum is thus greatly diminished, and the glottis usually remains open. I do not propose to discuss the obvious objections to this practice. I have employed it for over ten years without any cause for regret.

2. The teeth require particular protection under light anaesthesia. It is best to insert a mouth prop before induction, and to protect the point where the speculum rests with a piece of sheet lead.

3. On passing the instrument into the mouth the tongue should be manipulated to the left side, away from the slot; otherwise the organ may roll into the barrel and completely obstruct the view. When the glottis appears, intubation should not be attempted unless the cords are apart. Forcing a passage through the closed glottis is not only difficult, but likely to give rise to post-anaesthetic sore throat.

Difficulty in obtaining a view of the glottis with the speculum can frequently be overcome by moving the proximal end of the instrument towards the right corner of the mouth. This manœuvre permits the necessary extra elevation of the tip, and is preferable to hyperextension of the cervical vertebrae by lowering the head of the patient. In my experience, the latter alteration in position is more likely to increase the difficulty than to alleviate it.

Intubation through the Nose.

I have described elsewhere[1] a method of passing rubber tubes and catheters into the trachea by picking up the ends in the pharynx with the aid of a forceps and direct vision laryngoscope.

I have referred also to what I have called "blind intubation,"[2] which is performed without opening the patient's mouth. "Blind intubation" through the nose is, in my opinion, the most valuable manœuvre in the whole technique, and, as nasal intubation is so frequently of value in intra-oral operations, I propose to consider it fully. It has two advantages: (*a*) that it can be carried out under light anaesthesia without muscular relaxation (one might even go further and say that light anaesthesia is advantageous, as tonus of the jaw muscles actually draws the epiglottis away from the posterior pharyngeal wall); (*b*) that there is no risk of damage to teeth or growths by the speculum.

If you recollect my observations on the correct position of the patient's head, the facility with which intubation can be performed in this way is apparent. It is so easy in most cases that when a free choice is presented, and when there is no contraindication, I always select the nasal route. This experience has also been borne out while teaching students.

Technique of "Blind Intubation."

It is clearly essential that free nasal breathing should be present on at least one side, and where a difference in degree exists the side which is most patent should be selected. This point should be determined before induction. Cylindrical gum elastic catheters up to size 23 (French gauge) can usually be passed through the adult nose without causing injury. It is inadvisable, in my opinion, to use a larger tube of this or any other hard material, if trauma and bleeding are to be avoided. Catheters require a wire stylet bent in the form of a semicircle.

Commercial rubber tubing is the most satisfactory material. It is cheap and easy to obtain. It is firm enough to maintain its patency and sufficiently resilient to pass over mucous membranes without causing injury. Moreover, in the process of manufacture and subsequent storage in coils, rubber tubing becomes naturally curved. This curve is essential if the tube is to follow the course of the airway from nose to larynx. It also obviates the necessity for a wire stylet.

The tube should be cut obliquely, sterilized, and lubricated with soft paraffin. It is then passed along the floor of the nose close to the septum. The course of the tube should be mentally visualized as is that of the needle in regional anaesthesia. When a point is reached at which the respiratory sounds are heard at maximum intensity the tube will usually enter the glottis if pushed onwards during inspiration. In the case of failure, before resorting to the speculum and forceps, rotation of the tube to one side or the other will frequently bring its end into the desired position. Occasionally, gentle manipulation of the larynx with the left hand may be required in addition. In certain cases where the epiglottis is the obstacle the difficulty can be overcome by withdrawing the tube one inch and rotating it so that the concavity is posterior. If pushed onwards in this position the end of the tube will frequently pass behind the epiglottis. On again rotating to the original position with the concavity anterior the free end will enter the larynx.

The commonest question I have had to answer in demonstrating this manœuvre is: "How do you know the tube is in the trachea?" It seems to me obvious that if a tube 26 cm. in length is passed through the nose in its entirety the presence or absence of the free ingress and egress of air through the lumen is sufficient evidence of its position. Should the tube be in the oesophagus, or coiled up in the pharynx, no breath sounds are audible at the outer end.

Maintenance of Anaesthesia.

Having laid down the principle that intubation is of fundamental importance in endotracheal anaesthesia, I shall now consider maintenance. Here there is a choice of methods.

1. In the classical method of Elsberg a catheter is used for intubation, and air or a mixture of anaesthetic gases delivered under sufficient pressure to prevent collapse of the lung (even though both pleural cavities are opened) and to prevent also the entry of pus or blood into the trachea at any phase of respiration. Expiration takes place around the catheter, and if the pressure is effective the clinical picture is not always a pleasant one. The constant bubbling and spraying of blood by the return current obscures the operative field, and as the pressure cannot be reduced with safety if there is any possibility of blood reaching the trachea the obstruction to expiration becomes a strain on the patient. The surgeon also gets the full blast of the anaesthetic.

2. This method[3] comprises the use of a catheter and, in addition, an expiratory tube, which obviates most of the difficulties associated with insufflation through a single catheter. It should be remembered that the return current no longer drives blood away from the larynx. An effective pharyngeal gauze pack is therefore essential.

3. In this method intubation is carried out with a tube the calibre of which is sufficient to allow free to-and-fro respiration. The tube may be made of metal, of gum elastic, or of commercial rubber.[2]

Anaesthesia can be maintained on ordinary inhalation principles, and the system may be open or closed.

Several appliances and variations of technique have been devised in connexion with this method. Flagg's metal cannula commends itself on account of its simplicity. The Guedel and Waters inflatable bag provides absolute security against the entry of blood into the trachea, besides other advantages. Unfortunately, however, neither of these appliances can be used through the nose, and I trust that I have clearly pointed out the advantages of the nasal route for intubation.

Material Recommended for Intubation.

The material I have found to be most generally useful for intubation is commercial rubber, for reasons already stated. About six sizes are necessary, varying from 3/16 to 3/8 of an inch in calibre. The largest tube which the larynx will comfortably accommodate should be used. An exception is made in the case of infants under one year, for whom it is difficult to obtain a rubber tube with a wall which is thin enough and firm enough to maintain is patency under varying conditions of external pressure. For these children I use a special thin-walled gum elastic catheter, size 7 (English gauge), and have found this satisfactory.

Apparatus for Maintenance of Anaesthesia.

As already stated, when intubation is carried out anaesthesia can be maintained, if necessary, without any apparatus other than a drop bottle and a piece of gauze over the outer end of the tube. My own preference is nitrous oxide and oxygen with a minimum amount of ether. This mixture seems to me to compare favourably with ethylene. I use any efficient apparatus that is available in hospital work, but as bulk and portability are considerable factors in the conditions under which anaesthetists work in England I find a small continuous flow apparatus of my own design to be most useful. It is provided with a half-gallon bag of thin texture close to the machine and a delicate spring expiratory valve close to the patient. This valve is connected by a metal elbow to the tube in the trachea. I endeavour to interfere as little as possible with the normal respiratory mechanism of the patient. Low pressure is used as a routine, but ample high pressure is immediately available in case of emergency.

In every case gauze packing is used to ensure that breathing takes place through the tube and not outside it, and also to prevent blood from reaching the trachea. If carefully placed around the tube in the pharynx this packing is sufficient for practical purposes. In operations upon the nose the gauze keeps the soft palate in close apposition to the posterior wall of the pharynx. This method of packing is more effective than gauze or sponges in the post-nasal space, and is less likely to cause discomfort after operation.

Summary.

1. The fundamental principle of endotracheal anaesthesia is the provision by intubation of an airway that is proof against obstruction.
2. High-pressure insufflation is usually unnecessary.
3. Deep anaesthesia is not essential for intubation.
4. Dexterity in intubation minimizes the disadvantages.
5. Owing to the greater ease with which intubation can be performed through the nose this route should always be chosen when possible.

References.

[1] Magill: *British Medical Journal*, 1920, ii, 670.
[2] Idem: *Proc. Roy. Soc. Med.*, December, 1928, vol. xxii (Section of Anaesthetics, 4).
[3] Idem: *Lancet*, 1923, ii, 228.