THE TREATMENT OF ACUTE RESPIRATORY INFECTION IN INFANTS

BY

H. I. ARMSTRONG NISBET
Alder Hey Children’s Hospital, Liverpool, England

AND

FRANK WILSON
Alder Hey Children’s Hospital and Royal Liverpool Children’s Hospital, Liverpool, England

The mortality from acute respiratory infection in infants has been considerably reduced in recent years by the advent of antibiotic therapy. The application of new knowledge concerning fluid balance and feeding, together with advances in the nursing care, and attention to such factors as temperature, posture and humidity of the atmosphere have played important roles in reducing mortality.

Despite this progress, a certain proportion of cases still fails to respond to treatment. Such may be the case where antibiotics are used empirically or in inadequate dosage. Certain infections appear to be resistant to all antibiotic therapy. In some infants in whom there is a paucity of physical and radiological signs, the severity of the condition may not be fully appreciated. Treatment may then be delayed until the development of an obvious severe bronchopneumonia with cyanosis, dehydration and extreme toxaemia. Hypoxia and toxaemia lead to depression of the cough reflex. In such circumstances failure to clear secretions from the air passages results in severe respiratory obstruction.

The purpose of this paper is to show how it is possible to re-establish an adequate airway and improve aeration of the lungs. A series of cases is presented treated by methods that have been evolved using standard equipment readily available in all hospitals.

PRINCIPLES OF TREATMENT

The Relief of Respiratory Insufficiency

Respiratory insufficiency exists where gaseous exchange between the lungs and the blood is less than that between the tissues and the blood—that is, where external respiration cannot keep pace with internal respiration (Woolmer, 1956). The infant’s own efforts towards increasing exchange, by increased respiratory rate and effort, are demonstrably inefficient as they inevitably increase oxygen demands.

This discrepancy between oxygen supply and oxygen demand can be relieved in two ways.

(a) By increasing gaseous exchange.

(b) By reducing oxygen demands.

Increased Gaseous Exchange.

This may be effected by:

Removal of obstructing secretions.

(a) By suction applied to the nose, mouth and pharynx.

(b) By suction applied to the lower respiratory tract via an endotracheal tube, a bronchoscope or a tracheotomy tube.

The necessity to remove secretions which obstruct the air passage is well recognized in the operating theatre, and in the management of anterior poliomyelitis, tetanus and many varieties of coma. There is less appreciation of the possible effects of mechanical obstruction arising in the infant’s airway during the course of acute respiratory infections.

The value of oxygen therapy must be severely limited if it cannot reach the alveoli. Similarly, antibiotics, although invaluable, will do little good unless the airway remains adequate long enough for the patient to benefit from their action.

Re-expansion of collapsed segments.

(a) By suction through an endotracheal tube or bronchoscope.

(b) By the use of positive pressure after suction.

(c) By aspiration of pus and/or air from the pleural cavity.

(d) By suitable posture.

Restoration of function to areas of lung by these means must inevitably increase gaseous exchange.

Reduction of deadspace.

(a) By endotracheal intubation.

(b) By tracheotomy.
Suitable posture.

It has been shown that posture affects:
(a) the relative ease with which the various lung segments expand (Jackson Rees, 1958);
(b) overall compliance (Attinger, Herschfus and Segal, 1956);
(c) the efficient drainage of secretions from the bronchial tree (Quinn and Mayer 1929; McLaurin, 1934).

Reduction of Oxygen Demands

This may be achieved by:
Re-establishment of the airway, using any or all of the methods above.

Since hypoxia and carbon dioxide retention in certain degrees provide the stimuli for the increase in respiratory work, removal of these stimuli by adequate aeration of the lung will reduce effort.

Removal of secretions which increase the resistance to the flow of gases in the air passages must reduce energy requirements.

Respiratory obstruction, by causing increased intrathoracic negative pressure, may facilitate the formation of transudate. This in turn may result in limitation of gaseous exchange, a decrease in compliance and an increase in respiratory work in addition to impairing the diffusion of gases across the membrane.

Use of assisted or controlled respiration.
Judicious use of sedatives.
Avoidance of respiratory stimulants, which must increase the metabolic rate and oxygen demand.

Maintenance of Nutrition and Hydration

This paper is primarily concerned with the application of the principles enumerated above. Nevertheless, the maintenance of nutrition and hydration remains an essential aspect of treatment.

Dehydration results from respiratory distress and toxæmia, which impair the ability to feed adequately. The immature kidneys (Rickham, 1957) function even less efficiently as the high "volume obligatoire" required by the infant is not readily available. Acid-base balance in the blood is impaired not only by faulty ventilation, but by poor renal compensation.

Feeding may be maintained by a catheter inserted into the stomach. It is preferable that, where possible, this should be passed through the mouth, thus leaving the nasal passages clear. The presence of an endotracheal tube in the oropharynx precludes normal feeding, but as these children are so ill that they will not feed by mouth in any case, this is of little consequence. In such circumstances, feeding by tube becomes essential. Some additional benefit may be derived from the removal of air and gas from the stomach, thus reducing the work of the diaphragm.

The Early Institution of Efficient Antibiotic Therapy

A detailed discussion of antibiotic therapy is outside the scope of this paper, but it must be appreciated that, if this is to be efficient, reliable information regarding the nature of the infecting organism must be obtained early in the course of the disease.

The empirical use of drugs to which the organism may subsequently be proved insensitive is unavoidable in the early stages of treatment. However, secretions aspirated from the trachea and bronchi provide the bacteriologist with far more reliable diagnostic material than do either throat or laryngeal swabs. Thus endotracheal intubation and suction may facilitate the early use of a suitable antibiotic.

Mode of Treatment

It is desirable that the atmosphere, posture, humidity and temperature should be readily controllable and that the respiratory movements should be easily observed. Such conditions may best be achieved where the infants are nursed naked in incubators.

Restoration of the airway by intubation and suction forms the essential feature of the treatment in all cases we describe. In some instances, intubation has had to be repeated many times and in others it has been necessary to leave an endotracheal tube in position for prolonged periods. Controlled respiration has been found to be beneficial where exhaustion has been so severe as to render ventilation inadequate. On occasion sedation has proved helpful. Where secretions have been particularly tenacious, streptokinase has been used. Certain of our cases have required bronchoscopy and in others tracheotomy has been necessary. These aspects of treatment require some detailed description.

Endotracheal Intubation

When severe respiratory embarrassment results from acute infection in infancy, the indications for intubation are:
(a) Where obstructing secretions cannot be cleared effectively in the normal way, that is, where there is an ineffective cough.

(b) Where the child is too ill to maintain adequate ventilation by its own unaided efforts. The presence of an efficient cough mechanism is undoubtedly the most effective way of removing secretions. It follows that intubation is seldom necessary where this exists. On the other hand, failure to cough effectively, as evidenced by the audible accumulation of secretions in the larger air passages, or by the presence of atelectasis, will present a strong indication for intubation.

In such circumstances, the introduction of an endotracheal tube offers several advantages.

(a) Mechanical obstructions presented by the relaxed tongue, blocked nares and pharyngeal secretions are overcome.

(b) Repeated endotracheal and endobronchial toilets can be carried out by suction through the tube. Owing to the more vertical descent of the right bronchus, toilet of the right bronchial tree is easily performed, while it may be necessary to resort to bronchoscopy to clear the left bronchus.

(c) Deadspace is reduced. If the tidal volume of an infant is 10 ml and the deadspace is 5 ml, the effective tidal volume which takes part in respiratory exchange will be 5 ml. If, however, the tidal volume is only 6 ml, the effective tidal volume will be only 1 ml.

Intubation with an 00 gauge endotracheal tube reduces the deadspace above the subglottic region from 5 ml to 1 ml. Thus the effective tidal volume will be greatly increased with a corresponding reduction in tachypnoea.

Although an endotracheal tube offers increased resistance to breathing in a normal infant, where this resistance is already high due to the presence of secretions in the air passages it is likely that the removal of these secretions by intubation and suction will actually effect a reduction in resistance. Our cases have shown a marked fall in respiratory rate following such treatment. This would seem to indicate a diminution in respiratory effort and therefore in oxygen demand.

**Technique.**

A sterile tray containing apparatus necessary for intubation should now be standard equipment in the medical wards of children’s hospitals.

Intubation of an infant in extremis is not technically difficult. Any material present in the pharynx is quickly removed by suction. The laryngoscope is gently inserted, advanced down the pharynx into the oesophagus and withdrawn until the tip catches the epiglottis, when the larynx slides into view. A sterile Magill tube is now introduced. This should be of too small a bore rather than too large, and should pass into the larynx to a point just below the vocal cords. The length can roughly be estimated by measuring one and a half times from the corner of the mouth to the lobe of the ear. If the tube is too long, it will enter the right bronchus, thus adding to the respiratory embarrassment. Size 00 Magill tubes are used in most cases. Kinking of the tube will occur less readily if a firm tube is selected.

While infants up to two or three weeks of age, and those who are moribund present little difficulty, it may be wiser to produce muscular relaxation in older and more active children if intubation is to be accomplished with a minimum of trauma. Intravenous injection of 5–10 mg of suxamethonium will cause complete paralysis and thereafter intubation may be performed with ease following inflation of the lungs with oxygen from a face mask.

Following intubation a fine no. 3 Jacques rubber catheter, from which the end has been removed, is introduced into the trachea. Suction is applied and whatever secretion present is removed. As this forms valuable diagnostic material, the contents of the sterile catheter mount should be sent for investigation.

The lungs are now inflated with oxygen, the tube being connected to the T-piece circuit as shown in figures 1 and 2. If the lungs fail to expand when gentle pressure is applied to the bag, suction should be repeated until inflation is possible.

**Further Management.**

The subsequent treatment depends upon the child’s response. Where the condition is obviously much improved, with rapid return of normal colour to the mucous membranes and when coughing, stimulated by the presence of the tube, is active, then the tube should be removed. After inflation of the lungs with oxygen and careful pharyngeal suction, the tube is withdrawn in one smooth rapid movement. Auscultation near the mouth confirms that the airway is clear and that no laryngeal spasm exists.
Careful observation of the infant's condition is essential, as the lung segments may well collapse repeatedly. Special attention should be paid to the presence or absence of an effective cough and to the nature of air entry on auscultation near the mouth or nose. This latter measure may give an early indication of the gradual accumulation of secretions. Repeated examination of the chest is necessary as the signs may vary markedly from hour to hour. Careful attention should be paid to the state of hydration. Radiographic and biochemical investigations should not be delayed.

Repeated Intubation.

Should secretions continue to accumulate in the absence of an effective cough, repeated intubation and suction may well be required. It is desirable that all manoeuvres should be performed as gently as possible and that trauma to the larynx be avoided. A small dose of suxamethonium may help greatly to attain this aim.

In certain cases we have experienced considerable difficulty in distinguishing between areas of collapse and consolidation. If the air entry to an area of the lung should suddenly become markedly diminished then the diagnosis is usually obvious. The presence of moist sounds, in association with an area of diminished air entry may also suggest that accumulated secretions have resulted in collapse. On the other hand, the absence of moist sounds in such an instance is no proof that the signs are due to consolidation. We have been surprised to find that some areas thought clinically to show consolidation have been re-aerated following suction and positive pressure. Where such uncertainty exists intubation and suction may be a useful diagnostic procedure.

Prolonged Intubation.

Where the child is exhausted and respiration is inadequate to maintain oxygenation, the endotracheal tube must perforce be retained and controlled respiration instituted.

In such a situation, expert, detailed and constant nursing care is essential. The nursing staff has played an invaluable part in the management of these cases. The organization of specialized respiratory units for the management of these cases would seem desirable.

The nurse should be taught to watch and listen for any change in the character of breathing. The

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**Rees's modification of Ayre's T-piece circuit with Venturi device for the entrainment of air.**

A humidifier is normally interposed between the Venturi device and the T-piece.
Rees's modification of Ayre's T-piece circuit in use, with safety device.

A green rubber bag, as supplied by B.O.C., is connected to the T-piece circuit. Into the "tail" of this bag is inserted a Y-shaped glass connection. The second limb of this connection is attached to the glass tubing in a transfusion bottle, which is half full of water. The glass tubing dips well below the surface of the water.

"Inspiration" is effected by closing the third limb of the Y-shaped connection with the thumb of one hand, while the thumb of the other compresses the bag. The pressure in the circuit is then limited by the escape of gases through the limb of the Y connection attached to the transfusion bottle. "Expiration" is effected by releasing the pressure on the bag and removing the thumb from the limb of the Y connection.

circuit should be demonstrated and special emphasis laid upon all the possible means by which the airway may be blocked and the ways in which it may be restored.

Sudden onset of respiratory distress, with intercostal recession, cyanosis and diminished air flow through the tube, requires prompt attention. The smaller sized endotracheal tubes are thin walled and may kink. Such difficulties may be prevented if a reasonably firm tube is secured in the mid-line, the connection lying between the teeth or gums, where it cannot be blocked by biting. A gag made from a cut-down Guedel's airway may be useful in this connection. Careful packing of the mouth and pharynx with a lightly oiled gauze pack also limits the tendency of the tube to kink.

Failure to make a firm connection between the tube and its metal connection may lead to inhalation of the tube.

Should it be necessary to retain the tube in position for periods of longer than twelve hours, it is advisable to change it frequently in order to avoid blockage by inspissated secretions.

Suction

The majority of these children suffer from a generalized infection of the respiratory passages. Copious secretions may accumulate in the nose, pharynx, trachea and bronchi. As infants show a predilection for nasal breathing, it is desirable that the patency of the nasal passages should be maintained. Furthermore, if nasal secretions are not efficiently removed they will collect in the pharynx, giving rise to a mechanical obstruction. Pharyngeal suction, therefore, is a valuable thera-
peutic measure. It should be performed hourly, preferably before the child is due to be fed, in order to avoid regurgitation. Even when an endotracheal tube is in position, these measures should not be neglected. An adequate exposure is necessary and is easily obtained by depressing the tongue with a sterile spatula or spoon handle without causing trauma to the palate or posterior pharyngeal wall.

Suction through an endotracheal tube is not without certain hazards, and should only be performed by those who have received instruction. Care should be taken to ensure that the catheters are sterilized by boiling before and after use. Sterilization by means of solutions or by formalin vapour cannot be too strongly condemned. A firm rubber catheter of a thickness such as will permit the passage of air between itself and the wall of the endotracheal tube should be passed as far down the bronchial tree as possible. Care is necessary to avoid trauma to the tracheal wall and the catheter should be firmly compressed as it passes down. Suction is then applied as the catheter is withdrawn, removing secretions on the way. Failure to observe these precautions may result in considerable collapse of the lungs. Following suction, inflation of the lungs with oxygen should always be performed, further to minimize this danger. Some measure of restraint is advisable in the use of suction. It should only be applied where secretions are thought to exist and not as a diagnostic test of their presence or absence. Strict attention should be paid to asepsis.

Controlled Respiration

Controlled positive pressure respiration may produce certain adverse effects on the cardiovascular dynamics of adult subjects. It is believed that, in healthy infants, such effects are minimal (Rees, 1958). This is less likely to be true where circulatory collapse exists due to toxaemia, dehydration or the effects of prolonged hypoxia.

When the tidal volume is inadequate to maintain oxygenation, however, or the child is apnoeic, there is little choice but to control respiration. Beneficial effects should result from the improved ventilation and the reduction in oxygen demand consequent to diminished respiratory work. It is unlikely that positive pressure respiration will injure a normal lung provided that it is performed with care. Rees (1958) states that quite a high negative intrathoracic pressure may be reached in infants. The negative intrathoracic pressure produced by diaphragmatic movement is inversely proportional to the radius of the domes. As this radius is small in infants, they can produce pressures in the region of - 45 cm H$_2$O. Similarly, high positive intrathoracic pressures are known to be developed in the act of coughing—pressures far in excess of those used in positive pressure respiration.

The Rees modification of Ayre's T-piece circuit is shown in figure 1. As it stands, it is not suitable for use by untrained personnel. A further modification, described in figure 2, limits the pressure which may be applied to the lungs by manual inflation of the bag.

Controlled respiration with this equipment may be carried out safely by the nursing staff, provided that adequate instruction is given. Points to stress are that the bag must not be allowed to fill completely, being partially grasped in the ball of the hand, while pressure to inflate is exerted by the thumb. Pressure should be gentle and sufficient to ventilate adequately as judged by the movements of the chest. The pressure during the expiratory phase should be zero.

Ayre (1956) states that in clinical practice a fresh gas inflow of 1½—2 times the minute volume of the patient will ensure that there is no re-breathing.

Humidification

Humidification of the atmosphere is essential in all cases. Marshall and Spalding (1953) state that the aim should always be 100 per cent humidity. This is difficult to obtain where the incubators are frequently opened for feeding, auscultation and routine nursing care. Incubators should be opened, therefore, as seldom as possible, both to preserve the oxygenated humidified atmosphere and to avoid falls in temperature which may be serious in collapsed hypothermic infants. Where an endotracheal or a tracheotomy tube is in place, failure to provide adequate humidification will lead rapidly to the encrustation of secretions. In both these instances, the mouth and nose, which normally add most of the water vapour to the inspired air, are by-passed.

It is wise, therefore, to keep humidity settings
on the incubators at the maximum. Clinical impressions are that the addition of alevaire to the atmosphere is useful.

If controlled respiration is required, 100 per cent humidity can only be obtained by the use of a humidifier such as the "Radcliffe". Where this is not available the gases may be bubbled through water bottles in which the bubbles are broken up by passing through gauze or sponge. This method gives a humidity below the desired maximum (Marshall and Spalding, 1953).

The Atmosphere
It is generally agreed that prolonged inhalation of high concentrations of oxygen is undesirable. The concentration in many incubators, however, seldom reaches 50 per cent (Rickham, 1957). Where incubators are more airtight, it seems advisable that alevaire should be vaporized by air and an appropriate percentage of oxygen added to the atmosphere through a separate inlet. Controlled respiration with 100 per cent oxygen is likewise to be avoided. The introduction of a venturi injector device into the T-piece circuit enables the entrainment of air, so that the relative concentration of air and oxygen may be varied as desired.

Position of the Patient
If the child is to make the best use of its respiratory efforts it is desirable:

(a) That the inhalation of material from the nose, mouth and pharynx should be avoided.
(b) That the position should be such as will encourage the drainage of secretions from affected segments.
(c) That the position should allow the infant to ventilate its lungs with the minimum of effort.

These objectives, unfortunately, are not always compatible.

Most of these children have muco-pus in the nasopharynx. Quinn and Mayer (1929) and McLaurin (1934) have shown the ease with which material from the nose and sinuses may be aspirated into the lungs. The infant's predilection for nasal breathing has already been mentioned. From this the head down position might appear to have certain benefits to offer. Sticky mucus does not drain from the mouth with such facility as liquid vomitus, however, and this position has many disadvantages. Nasal secretions can and should be removed frequently by suction.

James, Brindlecombe and Weston Wells (1952) have shown that atelectasis in lower respiratory infection occurs most frequently in the lower lobes. Most of the cases in this large series, however, are in an older age group than those with which we have been concerned.

Certain considerations tend to show that the position of choice may be head up. Goodwin (1934) reviewed cases of lipoid pneumonia secondary to aspiration of oily substances. He found that the right lung was more often affected than the left and the upper lobes more frequently than the lower. Rees (1958) states that atelectasis due to secretions is more common in the upper lobes of infants than in the bases. This he ascribes to the abdominal type of respiration and the restricted movement of the upper part of the thoracic cage.

The routine nursing care of changing the child from one side to the other at regular intervals undoubtedly facilitates the drainage of secretions into the larger air passages, from which they may more easily be removed by coughing or by suction. Percussion of the chest wall also assists in this aim.

In respiratory distress there is an increase in respiratory work due to a decrease in compliance and an increase in mechanical resistance. Attinger, Herschfus and Segal (1956) studied a group of adults suffering from various cardiopulmonary diseases. They found that compliance was highest and mechanical resistance lowest in the sitting position. Thus these patients performed less work when sitting than when supine. Positions other than the sitting therefore produce a relatively greater oxygen demand, a condition to be avoided in pulmonary insufficiency.

It may be that these facts are applicable to infants. Certainly marked clinical improvement may be observed when they are made to sit up. This posture should allow the diaphragm to act at a better mechanical advantage. The infant must not be allowed to slump forward in a nest of pillows, however, or this advantage is lost.

In view of these considerations we have elected to treat these cases with the head end of the bed steeply raised on blocks, or with the incubator tray suitably tilted. The children are turned from side to side at regular intervals and are not encumbered by pillows.
Sedation

It may be considered that sedation in these cases is inadvisable, in view of the ever present dangers of hypoxia and carbon dioxide retention. Gaisford and Lightwood (1953) have favoured the use of pethidine in certain conditions of respiratory distress. We have found that, in several instances, a dose of 0.2 mg per lb. (0.45 mg/kg), by intramuscular injection, has had a quietening effect in restless infants. In such amounts it does not appear to cause significant respiratory depression and by virtue of its sedative effect, reduces oxygen demand.

Avoidance of Respiratory Stimulants

While certain concentrations of carbon dioxide stimulate respiration it seems likely that raised levels already exist in the blood where ventilation is defective (Goodman and Gillman, 1955). Further increase in the concentration in the inspired atmosphere may lead to respiratory depression.

It has been shown by Alschultz and Sulzbach (1947) and McDonald and Simonson (1953) that changes in blood carbon dioxide level affect the adult electrocardiogram. Reversible changes similar to those seen in ischaemic heart disease have been described by Pitman and Wilson (1955) in cases of respiratory embarrassment with carbon dioxide retention. It would be interesting to know if such changes occur in infants.

Whether a stimulant effect, obtained by carbon dioxide or by the use of such drugs as nikethamide, is desirable in an exhausted child may be doubted, in view of the increased oxygen demand which must inevitably result.

Temperature Control

It has been shown that adults adjust their rate and depth of breathing so that respiration is accomplished with a minimum of effort (Otis, Fenn and Rahn, 1950; McIlroy, Marshall and Christie, 1954). The theoretical minimum of effort in the newborn is thought to occur at a respiratory rate of 37 per minute (Cook et al., 1957). Work done increases as the rate rises above this figure and the metabolic rate may attain phenomenal levels.

From these considerations, it may be surmised that respiratory distress in infancy calls for a much greater increase in effort than in adult life.

Reference has been made elsewhere (Freier et al., 1957) to the pyrexia and exhaustion which may accompany increased respiratory effort. In two cases of hyaline membrane syndrome described by Cook and his colleagues (1957) the metabolic rate was increased by 400 per cent. As mechanical efficiency is low, a high proportion of the energy used in the increased respiratory effort will appear in the form of heat. Small wonder that the distressed infant, with its poorly developed heat regulating mechanism, commonly develops hyperpyrexia, which may be accompanied by convulsions.

It is surprising, therefore, to find that infants with marked pyrexia are still commonly nursed under layers of clothes and blankets, or in incubators at high temperatures. Such treatment can only have the effect of raising the metabolic rate and oxygen demand.

Where the child is collapsed and exhausted, however, the temperature rapidly falls, sometimes to levels well below 90°F. In such circumstances it is essential to maintain the temperature of the incubator at a high level. Thus the number of occasions when it is opened for nursing purposes should be kept to a minimum.

Bronchoscopy and Tracheotomy

In many cases we have found it possible to re-expand the lungs simply by intubation and suction followed by positive pressure. The right lung responds well to this treatment but in many cases the left lung also has benefited to such an extent that bronchoscopy has not been required. Where the response has been less satisfactory bronchoscopy has proved useful.

Modern thought does not subscribe to the view that tracheotomy in infants invariably leads to a fatal outcome. A planned operation in theatre, followed by judicious use of antibiotics, devoted nursing care, atmospheres of high humidity and careful endotracheal toilet, gives even the youngest child a fair chance of survival.

It is not proposed to discuss the management of tracheotomy, but some reference is made to the subject later in the comment on case history no. 8.

Streptokinase and Streptodornase

In certain cases, where mechanical obstruction due to tenacious or crusted material was causing
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alarm, we have found these preparations valuable when instilled into the bronchial tree. In other cases, liquefaction of pus has appeared to cause rapid spread of infection. It may therefore be advisable to wait until systemic antibiotics have had time to be effective before using these substances.

TYPES OF CASES

From a therapeutic viewpoint it is desirable to define several broad groups of clinical conditions.

(1) Upper respiratory tract infection may predominate, as in cases of laryngotracheal bronchitis, where subglottic oedema may be sufficiently severe to call for early tracheotomy.

(2) Bronchitis or bronchopneumonia may exist where copious, sticky, muco-purulent secretions remain uncleared from the larger air passages and may be followed by atelectasis, consolidation or abscess formation. This group presents the anaesthetist with the most promising field for intervention.

(3) Where the obstructing secretions are situated mainly in the smaller bronchioles, efforts to remove them are likely to be less rewarding. Repeated suction may be required to remove them as they are extruded into the larger bronchi. The effort entailed in maintaining ventilation in these cases of bronchiolitis is very great and many have required prolonged intubation and controlled respiration.

(4) Abscess formation is frequent in staphylococcal infections. Such lesions may rupture into a bronchus, causing sudden acute respiratory obstruction. Not uncommonly, however, they rupture into the pleural cavity, causing a pyopneumothorax, a condition which calls for careful management.

CASE HISTORIES

In view of the urgent problem presented by the cyanotic, gasping, collapsed infant, we have had little choice in the cases we have treated. Some children are moribund on admission. Seven cases, not included in our series, have died before we could reach them, even though the delay was short. In some, postmortem examination has revealed the presence of associated lesions, as can be seen from table I.

Controlled investigation has not been possible in these circumstances and early investigations by such means as radiography have often been precluded. Results are therefore difficult to assess by any means other than by clinical examination.

The principal features of eighteen cases of acute respiratory infection are indicated in table I. In order to avoid tensive repetition, certain of these cases which demonstrate particular methods of treatment are presented and only two are described in detail. In this series there have been five deaths, which will be discussed collectively.

Case No. 15.

**Pharyngeal Suction and Postural Drainage**

A female child aged 6 weeks, birth weight 7 lb, 3 oz. (3.25 kg), was admitted suffering from cyanosis and respiratory distress.

On examination, the child was cyanotic and the respiratory rate was 48 per minute. She made efforts to cough, but was unable to clear the accumulated secretions from the pharynx. Breath sounds were harsh with crepitations throughout both lung fields.

The pharynx was cleared by suction and her colour improved considerably. As she continued to cough, the pharyngeal suction proved sufficient to maintain her airway. She was nursed in the sitting position in an atmosphere of oxygen and alevaire. Postural drainage aided by percussion of the chest was encouraged. She made an uneventful recovery.

**Comment.** This infant responded well to the usual medical care once the airway had been cleared and maintained. The value of repeated pharyngeal suction was clearly demonstrated.

Case No. 14.

**Intubation and Suction**

A female child aged 3 weeks, birth weight 5 lb, 9 oz. (2.5 kg), was admitted with a history of "snuffles" and disinclination to feed of several days duration.

On examination, she showed cyanosis, dyspnoea and marked rib recession. The breath sounds were harsh, with coarse crepitations at the left base.

On the evening of her admission her condition worsened, with only a temporary response to pharyngeal suction, oxygen and alevaire. She became unconscious with shallow ineffective respirations, poor air entry into all areas of the lungs and periods of apnoea.

Endotracheal intubation was performed without relaxation and a considerable quantity of tenacious sputum removed by suction. Normal colour rapidly returned to the mucous membranes and she coughed strenuously with the tube in place.

Following this procedure, tidal ventilation remained adequate. The air entry improved in all areas and cough remained effective. Further intubation was not required. The child responded satisfactorily to antibiotics and was discharged in due course.
Comment. Where the secretions are tenacious and accumulate in quantity, anoxia will eventually depress the cough reflex. In such a case it is difficult to see any alternative to intubation and suction.

Case No. 17.

Repeated Intubation and Suction

A male child aged 6 weeks, birth weight 5 lb. (2.25 kg), was admitted suffering from cyanosis and respiratory distress. For the three weeks prior to admission he had been treated at home with oral penicillin and terramycin.

Shortly after admission his condition deteriorated. Treatment was continued with penicillin, streptomycin, aureomycin and cortisone. During the next few hours his respiratory rate rose to 96 per minute. He had no air entry except at the left apex.

Intubation was performed without relaxation and 3 ml of blood-stained mucus were aspirated. In the next 2 hours his respiratory rate fell to 50 per minute. During the next 5 days he required daily intubation and suction.

He made an uneventful recovery and was discharged 3 weeks later.

Comment. This case illustrates the fact that respiratory distress may become more severe in spite of antibiotic therapy. When the respiratory obstruction was removed by suction, the respiratory rate fell markedly within half an hour and there was progressive clinical improvement.

Case No. 3.

Prolonged Intubation, Pleural Drainage

A male child aged 5 weeks, birth weight 8 lb. (3.5 kg), was admitted with a history of "snuffles", reluctance to feed and diarrhoea of 24 hours duration.

On examination his colour was good, there was some nasal discharge and scattered rhonchi were heard throughout the lung fields. The heart sounds were normal.

Thirty-six hours after admission the child collapsed before being fed. The skin was pale, mucus membranes blue-grey; rib recession was marked and there was mediastinal shift to the left with no air entry to the left lung. There were prolonged periods of apnoea.

Intubation was performed with the object of re-expanding the left lung. The response to suction was poor and gentle positive pressure was required to maintain ventilation. Bronchoscopy revealed the presence of scanty secretions in both main bronchi which were removed by suction. A loud rough systolic murmur was now evident across the entire praecordial region.

As positive pressure resulted in a marked mediastinal shift to the right, the presence of a bronchopleural fistula was suspected. This was confirmed by radiographs which demonstrated a left pyo-pneumothorax.

The child was transferred to theatre, where drainage of the pleural cavity was performed. Following this procedure the child remained pale, blue, and collapsed in spite of the presence of an efficient underwater seal. Respiration still required to be controlled. The loud systolic murmur was still evident. Intramuscular erythromycin was administered.

During the night endotracheal suction was required repeatedly. The tidal exchange improved slowly and it became possible to discontinue controlled respiration.

By the following afternoon the child's condition had greatly improved. He remained pink in the oxygenated and humidified atmosphere of the incubator; tidal ventilation was reasonable and coughing was active. It was deemed advisable to remove the tube, which had by now been in position 24 hours, during which period it had twice been changed.

The following day saw this satisfactory progress continued. The systolic murmur became less marked. That night, however, the child again collapsed. A delay of 8 minutes occurred before intubation, when it was found that the trachea and bronchi were completely blocked by secretions. Inflation of the lungs prior to suction was quite impossible and by the time the airway was re-established the child was dead.

Postmortem examination showed staphylococcal pneumonia with left empyema; purulent pericarditis and acute bacterial endocarditis.

Comments. (1) Positive pressure must be used with caution in those cases where a staphylococcal abscess may have ruptured into the pleura. If the presence of a bronchopleural fistula is suspected, it may be wise to confine treatment to clearing the airway by intubation and suction and then refrain from exerting positive pressure until such time as the surgeon is ready to insert pleural drainage.

(2) It is worthy of note that, in spite of the postmortem findings in the heart, the immediate cause of death in this child was respiratory obstruction due to massive accumulation of secretions, possibly arising from the sudden rupture of a staphylococcal abscess into a bronchus.

(3) Intubation and suction over a period of 24 hours had no ill effect on the larynx or trachea.

Case No. 16.

Prolonged and Repeated Intubation

A female child aged 14 days, birth weight 5 lb. 13 oz. (2.75 kg) was admitted suffering from distressed inspiration, cyanotic attacks and inability to suck at the breast.

February 6, 1958.

1 p.m. On examination the temperature was 95°F, the pulse and respiratory rates were 142 and 64 per minute respectively. The infant was cyanosed and had marked respiratory distress with intercostal recession.
Air entry was absent except over the right upper zone.
A marked systolic murmur was audible over the praecordium.
A laryngoscope was inserted into the pharynx and purulent secretions were seen to well up from the laryngeal aperture. The aryepiglottic folds were markedly inflamed.
An endotracheal tube was inserted and 3-4 ml of thick yellow pus were aspirated, Air entry was immediately evident over the right lung except at the base. A definite but less marked improvement was noted in the left side of the chest.
The endotracheal tube was strapped in position and she was nursed in an incubator with the head elevated. The oxygen was humidified by alevaire.

February 7, 1958.
1 a.m. Moist sounds were evident in all lung fields and 1 ml of thick pus was aspirated from the endotracheal tube.
3 a.m. 3-4 ml of thick yellow pus were aspirated from the endotracheal tube. The respiratory rate fell to 34 per minute and the colour became pink.
8 a.m. She became dyspnoeic and a further 1 ml of pus was aspirated from the endotracheal tube with some improvement.
10 a.m. Baby collapsed, became apnoeic and the heart rate slowed to 24 per minute. It was impossible to inflate the lungs by positive pressure. The endotracheal tube was removed and found to be completely blocked by inspissated secretions. Another tube was immediately inserted, secretions aspirated and the lungs reinflated by positive pressure with restoration of air entry to both lungs. Widespread crepitations were audible.
1 p.m. 1 ml of streptokinase (100 units) was introduced into the endotracheal tube and left for half an hour. Aspiration of a quantity of pus was associated with improvement in colour and activity.
Aspiration of smaller quantities of secretions was performed every 1-2 hours according to their presence in the endotracheal tube. Streptokinase was introduced 3-hourly.
11 p.m. Respirations were regular at 36 per minute, the air entry was good and widespread crepitations were present. The colour was satisfactory and the endotracheal tube was removed. The systolic murmur was barely discernible.
The pharynx was sucked out hourly and care taken to remove all secretions, an adequate exposure being obtained by placing a spatula in the baby's mouth and depressing the tongue.

February 8, 1958.
Moist sounds were audible at both bases. The respiratory rate had risen to 50 per minute. She was intubated and 1 ml of pus was removed. One hour later, the respiratory rate had fallen to 40 per minute. She took her feeds well and started to cry.

February 9, 1958.
She developed cyanosis, oedema of the sacrum, hepatomegaly and splenomegaly. The crepitations were more obvious on auscultation.
Intubation later on in the day resulted in the aspiration of 1 ml of whitish secretions.

February 10, 1958.
The hepatomegaly had decreased and oedema of the sacrum and the cyanosis had disappeared.
Intubation produced several plugs of yellow secretions. A considerable quantity of nasal secretions was also aspirated.
During the next 3 days the general condition and air entry improved. She was intubated daily and smaller amounts of secretions removed.

February 16, 1958.
The chest was clinically clear. She remained in hospital for a period of 2 weeks because of social conditions.

Comments. This baby was moribund on admission with secretions pouring from the pharynx.
(1) A phenomenal quantity of purulent secretions was aspirated during the first 24 hours. Even though the initial suction produced considerable aeration of both lungs, it was necessary to repeat the aspiration at frequent intervals in order to maintain this improvement.
(2) At one stage of the treatment blockage of the endotracheal tube with inspissated secretions resulted in collapse, bradycardia, apnoea and cyanosis. Fortunately the airway was quickly restored.
To avoid this complication, it was our policy to change the tube every 12 hours even if it appeared to be patent. We now consider, however, that the presence of abundant tenacious secretions warrants a change of endotracheal tube every 6 hours. Another reason for changing the tube periodically is that its junction with the metal endotracheal connection is often soaked in saliva. This tends to make the union less secure and the two may come apart.
(3) It is essential to have a sterile endotracheal tube ready for insertion in an emergency.
(4) In view of the fact that the larynx was very inflamed on admission, it may be considered that intubation would necessitate a tracheotomy. The baby was intubated seven times in all and in the initial stage the endotracheal tube was left in position for 24 hours. In spite of this treatment there was no evidence of any laryngeal stridor.

Case No. 11.

Repeated Intubation, Prolonged Intubation, Controlled Respiration, Tracheotomy
A male child aged 1 month, birth weight 5 lb. 6 oz. (2.5 kg), was admitted with a history of reluctance to feed, "snuffles" and cyanotic attacks.
On examination he was cyanosed, deeply uncon-
scious, with atony of all limbs. His colour improved in oxygen but respiratory distress remained severe, with marked rib recession and long periods of apnoea. The percussion note was dull over both lung fields. Breath sounds were absent over the whole left lung and crepitations and expiratory rhonchi were marked on the right side.

The larynx, when visualized, was found to show marked inflammation and a thin stream of pus trickled through the rima glottidis. The child was intubated, without relaxant, and a large quantity of fluid secretions removed by suction, aided by posture and percussion of the chest.

Following this procedure the air entry was greatly improved in all areas, the mucous membranes were pink and the child was coughing actively. The endotracheal tube was removed and the airway at this stage appeared satisfactory.

Improvement was maintained during the next 2 days. Feeding by tube was accomplished and the airway maintained by nasal and pharyngeal suction with posture and percussion of the chest.

Thereafter the condition again became critical, with cyanosis, rib recession and little air entry into the left lung. During this period he required repeated intubation and suction. The laryngeal oedema became so severe as to cause respiratory obstruction.

In view of this and the fact that periods of apnoea were frequent, the endotracheal tube was retained for some hours and respiration controlled. Tracheotomy was later performed as an elective procedure in theatre.

During the next week the child improved. Suction was maintained through the tracheotomy tube, on each occasion being followed by reinfation of the lungs through a cut-down Magill tube inserted into the tracheotomy tube. Periods of restlessness responded well to small doses of pethidine by intramuscular injection.

After 10 days the larynx being reasonably healthy, it was possible to remove the tracheotomy tube. Progress thereafter was satisfactory and the child was discharged home 26 days after admission.

Comments. (1) Where mechanical obstruction of such degree exists, there would appear to be no alternative to intubation and suction, whether the larynx be oedematous or not.

(2) In conjunction with modern antibiotics, tracheotomy gave rise to no difficulties other than those associated with the small size of the infant’s air passages.

Case No. 8.

Tracheotomy

A female child aged 24 months, was admitted suffering from respiratory distress and cyanosis.

September 26, 1957.

On examination she was extremely ill, cyanosed and restless. The breathing was shallow and irregular. Marked rib recession was accompanied by action of all her accessory muscles of respiration. She was unable to cry.

Auscultation showed diminished air entry throughout the chest, which was due to laryngeal oedema. There were no adventitious sounds in the lungs, but secretions were audible within the trachea.

A tracheotomy was performed, and thick yellow pus was aspirated from the trachea. Restoration of the airway was accompanied by the disappearance of all the signs associated with respiratory embarrassment.

She was nursed in an oxygen tent with alevaire, the secretions were aspirated and the position changed periodically. She progressed satisfactorily.

September 29, 1957.

The mucus became more tenacious and within a few hours she gradually developed her original signs of respiratory embarrassment. Radiography showed collapse of the right middle and left lower lobes.

Bronchoscopy through the tracheostomy under general anaesthesia showed the presence of a considerable quantity of sticky, blood-stained secretions. These were removed and the airway restored with considerable clinical improvement.

September 30, 1957.

She again deteriorated. The airway appeared clear, but on auscultation there was absence of air entry in the left side of the chest. Bronchoscopy revealed the presence of hard, inspissated and blood-stained material which was removed by forceps and suction. Her condition improved and radiography showed that the left lower lobe had expanded but there was “shadowing in the right upper and middle zones.”

15 hours later. The above picture was again repeated and bronchoscopy enabled further removal of tracheal casts.

October 1, 1957.

A similar episode necessitated bronchoscopy with toilet to the bronchial tree. Her clinical picture, however, did not improve as well as previously. Respiration remained somewhat laboured and the child appeared to be exhausted.

3 hours later. Her dyspnoea increased and it was considered unlikely that she had had time to form further tracheal casts. 3 ml (100 units) of streptokinase were injected through the tracheostome and three hard inspissated clots followed by a fair amount of thin yellow pus were aspirated with considerable improvement in her condition. Streptokinase was injected 3 times a day for a period of 3 days.

In view of her desire to cough spontaneously during the above period of treatment it was decided to modify the standard tracheotomy tube. An Alder Hey tracheotomy tube (figs. 3, 4) was inserted which enabled her to cough effectively. The secretions coughed into the larger bronchi were then removed (Wilson, 1958).

October 11, 1957.

She gradually improved and the occluder was inserted into the tracheotomy tube.

October 22, 1957.

The tracheotomy tube was removed.

October 30, 1957.

She was discharged.
**Comments.** (1) It is essential to humidify the inspired air of patients subjected to tracheotomy, especially if secretions are abundant. In this case we had no humidifier, the inspired air being bubbled through water. It was feared from the start of treatment that tracheal casts would be produced and our suspicions were soon found to be correct.

It is probable that many of these complications would have been avoided if humidification had been satisfactory.

(2) This child had attempted to cough throughout the disease, but was unable to clear the bronchi of secretions.

The smaller divisions of the bronchial tree may be cleared effectively by one method only. The secretions must be coughed up into the larger bronchi. Patients with tracheotomies, however, are unable to cough effectively because they are unable to build up the requisite intrathoracic pressure, as the larynx is partly deprived of its natural function. In the adult, if the patient is conscious, this disadvantage may be obviated by asking him to inspire, when coughing may be made effective by occlusion of the tracheostome. Smaller children and especially infants usually will not co-operate in this manner. Even if they do, the respiratory rate is much higher and it is difficult to correlate occlusion of the tracheostome with the inspiratory and explosive efforts of the child. Occlusion of the tracheostome at the wrong time will cause distress due to the resultant feeling of suffocation. Also, the increased negative pressure arising in the alveoli may cause further alveolar collapse.

It was with the above factors in mind that it was decided to modify the tracheotomy tubes in present use (figs. 3, 4). The occluder, when inserted, restores the normal anatomical airway. If the child is trying to cough either spontaneously or after stimulation by catheter the inner tube may quickly be removed and the occluder inserted. The normal airway being thus restored, coughing will be instantly effective, provided the laryngeal orifice is not completely occluded. Any sputum produced may then be expectorated through the normal channels or collected from the larger bronchi by means of a catheter, on removal of the occluder.
This method, therefore, has the advantage of restoring the normal anatomical airway which may again be converted into a tracheotomy in a few seconds.

DEATHS

Of the eighteen cases presented in table I there were five deaths (cases 1-5).

(1) A malnourished premature infant, whose circulation failed to respond when adequate aeration of the lungs was re-established. The child remained pale, apnoeic and hypothermic in spite of controlled ventilation and good air entry into all areas. She eventually died from circulatory failure after efforts to correct this had proved unsuccessful. It is probable that she had been subjected to prolonged hypoxia.

Postmortem examination revealed scattered areas of consolidation in both lungs, free fluid in the pleural and peritoneal cavities and a patent ductus arteriosus.

(2) This child responded well to intubation and suction on two occasions. During the night he became totally obstructed, due either to inhalation of vomit or massive accumulation of secretions, and died of asphyxia before expert attention was available. Intubation was performed and inflation of the lungs found to be impossible prior to the removal of obstruction material by suction.

(3) This case has already been described and attention drawn to the fact that, despite grave cardiac lesions, death was primarily due to mechanical obstruction of the airway.

(4) A premature infant whose respiratory distress was due to bronchiolitis. He responded well to intubation and controlled respiration. After being intubated nine times, and for several prolonged periods, laryngeal oedema became so severe as to necessitate tracheotomy. His postoperative condition was very satisfactory.

During the night he became cyanosed, failed to respond to inflation of oxygen through the tracheotomy tube and rapidly died. Unfortunately we were not present and were unable to assess the state of the airway as the tracheotomy tube was removed soon after death. The history obtained from those in attendance suggests that the tracheotomy tube had become dislodged and was no longer in the trachea.

Autopsy showed patchy collapse of both lower lobes, with scattered areas of inflammation. There was some degree of cerebral oedema.

(5) A twin, this child was the elder brother of case no. 6. He was admitted one day later and followed the same downhill course, until, collapsed, cyanosed and with totally inadequate tidal ventilation and poor air entry in all areas of both lungs, he required intubation and suction.

He responded well. The mucous membranes became pink, and he coughed on the tube. Respirations remained periodic in character, however, and it was considered wise to retain the tube in position and control respiration when required.

The tube was changed at frequent intervals and suction applied as required. Unfortunately, again at a period when we were unable to provide instant attention, the tube became blocked by secretions and the child died from asphyxia before they could be removed.

Of these five deaths, at least three are primarily due to respiratory obstruction. It is to be hoped that, when these cases are concentrated in a single unit where expert attention is instantly available at all times, such deaths will prove to be avoidable.

DANGERS AND COMPLICATIONS

That many difficulties may be encountered in the management of these cases may be clear from the case histories above. Constant detailed supervision is essential to avoid and overcome the many possible complications.

The greatest danger, even with an endotracheal tube in place, still comes from respiratory obstruction, due to the accumulation of secretions or blockage of the tube from various causes.

Laryngeal Oedema.

It is held in some quarters that intubation of the infant’s larynx frequently results in oedema which may require tracheotomy for relief. During the past five years 35,000 children of all ages have been intubated for surgical purposes at Alder Hey and Royal Liverpool Children’s Hospitals. This number has included many hundreds of infants. No such case has yet required tracheotomy as a result of laryngeal trauma.

Where respiratory infection exists, however, laryngeal oedema must be accounted more likely. Case no. 11 already had marked laryngeal oedema before intubation, which undoubtedly aggravated the condition and necessitated tracheotomy. Case no. 4 similarly had a moderate degree of laryngeal oedema prior to intubation and tracheotomy was required after the procedure had been repeated nine times. It may be thought inevitable that a certain proportion of cases will require tracheotomy where such methods of treatment are essential to overcome respiratory obstruction.

In these cases without marked primary oedema, however, repeated and prolonged intubation have resulted in remarkably little damage to the larynx. Several additional cases of neonatal respiratory distress, not primarily of an infective nature, have been treated with endotracheal tubes in position for several days without harmful results to the
larynx. In one remarkable case of neonatal tetanus, Rees and his colleagues retained an endotracheal tube in position for 34 days and performed bronchoscopy twice daily without marked laryngeal oedema.

With these facts in view, we consider that the advantages offered by intubation by far outweigh the possible disadvantage of laryngeal oedema.

**Bronchopleural Fistula.**

Spontaneous rupture of a lung abscess may occur into a bronchus or into the pleural cavity, or both. If the bronchial tree is flooded by secretions, intubation and suction may be required to prevent asphyxia. That the use of positive pressure may produce a pneumothorax in these cases is well shown in case no. 3.

It follows that such a possibility must be constantly kept in mind, especially where the infecting organism is the staph. pyogenes, and careful watch maintained on the response of the lungs and mediastinum to positive pressure.

Where such a condition is known to exist and intubation and suction are indicated, it is wise to refrain from using positive pressure until preparations for pleural drainage are complete.

**SUMMARY**

In spite of modern advances in treatment, there is still a significant rate of mortality in infants who suffer from acute respiratory infections.

Failure to clear secretions from the air passages results in severe respiratory obstruction and increasing hypoxia. Oxygen demand is increased by virtue of the increased respiratory effort, while oxygen supply is diminished because of the defective ventilation.

When such a state of respiratory insufficiency exists, antibiotics are of little value unless the airway can be maintained until such time as they can exert their beneficial effect. Similarly, an obstructed airway must reduce the value of oxygen therapy.

Methods by which this state of respiratory insufficiency may be alleviated are discussed. These include the use of endotracheal intubation, suction, bronchoscopy, tracheotomy, posture and humidity; and of controlled respiration where the infant is too weak to maintain adequate ventilation by its own unaided efforts.

A series of eighteen cases treated by such methods is described. Thirteen of these infants survived. Several case histories are presented in some detail while others are included in tabular form.

The five deaths which occurred in this series are discussed. In certain of these cases the presence of associated lesions rendered survival unlikely.

Some complications which may arise are mentioned, in particular those arising from endotracheal intubation in infants. While these problems exist, they should not be held to contraindicate this procedure, especially in cases where intubation and suction are essential for relief of respiratory obstruction and the re-establishment of adequate ventilation.

**ACKNOWLEDGMENTS**

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Our thanks are also due to Mr. A. Rutana for his valuable advice in the management of those cases which required tracheotomy. We are indebted to the Consultant Physicians of Alder Hey Hospital, who allowed us to treat these cases, and to the Junior Medical and the Nursing Staffs for the continuous care which they devoted to these infants.

We also thank Mr. R. Rodney Green for the photographs and Miss E. A. Kidd for her patience and help in the preparation of the manuscript.

**REFERENCES**


CORRESPONDENCE

HALOTHANE AND THE ROWBOTHAM'S BOTTLE

Sir,—A few weeks before publication of my paper "Halothane concentration from a Rowbotham's bottle in a circle absorption system" (Brit. J. Anaesth. (1958), 30, 312) there appeared on the market a modified Rowbotham's bottle produced by the British Oxygen Company; this version is wickless and has downward facing ports and a larger liquid container. The company claims that it delivers trichloroethylene vapour in similar concentrations to the old pattern (B.O.C. and M. & I. E. makes); this may or may not be so, but when used in a circle absorber with halothane I find that concentrations in excess of the figures stated in my paper are obtainable. Actual readings cannot at the present time be given until further more accurate estimations have been made; however, as a rough and safe clinical guide, half to three-quarters “ON” with the new bottle is equivalent to “FULL ON” in the old, for vaporization of the first 10–15 ml of halothane, i.e. for the first hour.

A new vaporizer, offering minimal resistance to respiration, has been designed and is in the process of manufacture, testing and calibration, but this will not be available for purchase for some months, meanwhile it seems advisable to warn would-be users of the newly introduced B.O.C.'s Rowbotham's bottle of the possibility of now producing concentrations of halothane in a circle system in excess of 3.5 per cent.

It was reassuring to see confirmatory clinical evidence by Brown and Woods (Brit. J. Anaesth. (1958), 30, 333 and 338) for a lack in build-up of concentration of halothane with a circle absorber but I feel it is a pity that they should advocate disembowelling and relining an otherwise satisfactory piece of apparatus when they already possess an adequate alternative.

P. J. C. BURTON
Southlands Hospital,
Shoreham-by-Sea

ERRATUM

The following correction should be made to the paper on "Halothane concentration from a Rowbotham's bottle in a circle absorption system" by P. J. C. Burton in the July 1958 issue (Brit. J. Anaesth., 30, 312):

Page 312, column 2, line 21, should read:

"... Atropine 0.6 mg"