The value of prolonged nasotracheal intubation of certain babies and children with reversible respiratory inadequacy has become recognized as a result of the postoperative management of neonatal babies. In certain situations, the procedure may be used as an alternative to tracheostomy and may be effective when tracheostomy might be ill-advised. Its value lies in: (i) The ease and rapidity of performance by those used to passing endotracheal tubes, (ii) The effective reduction of deadspace when this is critical, (iii) Its usefulness in allowing control of moderate secretions, (iv) The ability to bypass upper respiratory tract obstructions, particularly when the nature of the obstructions may be such as to render tracheostomy hazardous, (v) The effective use of controlled ventilation when this is indicated, particularly in the baby, (vi) The avoidance of some of the hazards of tracheostomy, particularly in the neonatal baby.

Breath is life; as breathing fails, life slowly ebbs away. In few situations is this more apt than in the sickly newborn infant whose lungs may be ill developed, collapsed, or pneumonic, and who fights for his breath and his life through small respiratory passages so easily blocked by spasm and secretions. He needs respiratory aid.

Laryngeal intubation with silver tubes was common practice when diphtheria was prevalent, Scholes, for instance, reporting a series of 1,175 cases (O’Dwyer, 1885; Scholes, 1927). Tracheostomy has long been a standard method for the relief of urgent laryngeal obstruction and, particularly in more recent years, for managing respiratory difficulties of many and varied causes, but the problem of the retained tracheostomy tube has limited the usefulness of this procedure in the very young.

CASE 1. Baby D.S., with a repaired oesophageal atresia, in such manner survived a period of respiratory difficulty, but at the age of 7 months had a retained tracheostomy tube which had been unsuccessfully removed several times. At bronchoscopy it was evident that his trachea collapsed at the tracheostomy site and a nasotracheal polyvinyl tube was passed and left in situ for 5 days, until it was hoped that scarring at the tracheostomy site would prevent tracheal collapse. Using combined local and general anaesthesia to avoid spasm the tube was thenatraumatically withdrawn and the baby has breathed naturally for 12 months since.

This case, together with other reports, especially from the Adelaide Children’s Hospital (Allen, personal communication, 1963), led to a trial of intubation in babies and later in older children for extended periods, and during the past fifteen months fifty patients with ventilation difficulties have had this procedure performed at the Royal Children’s Hospital, Melbourne, with encouraging results. A further forty have been intubated for less than twenty-four hours. In this way the well-known tracheostomy hazards of retained tube, mediastinal emphysema, pneumothorax, and the inherent difficulties of its performance in certain situations have been avoided, though to be sure there are complications associated with an indwelling tube. The procedure may be used as an alternative to tracheostomy when some form of artificial airway is needed for the management of respiratory infection or obstruction, or ventilatory inadequacy, for relatively short periods of up to fourteen days.

INDICATIONS FOR NASOTRACHEAL INTUBATION
(TABLE I)

Postoperative.
At present ventilatory difficulty in the postoperative period is the commonest indication, particularly in the newborn baby. From the earliest
Radiographs demonstrating pulmonary insufficiency.

(a) Following repair of diaphragmatic hernia. Left pulmonary agenesis; right pulmonary collapse and consolidation; left pleural drain tube; and mediastinal shift.

(b) Following repair of oesophageal atresia. Right pneumothorax with progressive recovery. Nasal endotracheal tube in position.

(c) Following repair of exomphalos. High splinted diaphragm. Horizontal rib disposition.
TABLE I
Indications for intubation

1. POSTOPERATIVE
(a) Pulmonary insufficiency.
(b) Obstruction associated with exudate.
(c) Pure mechanical obstruction.
(d) Motor pathway failure.

2. REVERSIBLE RESPIRATORY DISEASE
(a) Pulmonary insufficiency.
(b) Obstruction associated with exudate.
(c) Pure mechanical obstruction.
(d) Motor pathway failure.

3. RETAINED TRACHEOSTOMY TUBE

4. AID TO MECHANICAL VENTILATION

days of endotracheal anaesthesia for surgery in neonates, a proportion of babies, though otherwise apparently in good condition, failed to breathe well post-anaesthetically because of several factors which included, either separately or together, pulmonary hypoplasia, surgical trauma, cold, anaesthetic narcosis, inadequate blood replacement, and the effects of incompletely excreted or metabolized muscle relaxants. Nowadays respiratory depression from anaesthetic causes is not such a problem, but the inbuilt deficiencies of pulmonary development and the inescapable trauma of surgery remain to complicate the postoperative respiratory picture. All too commonly in the recent past the baby awakened after anaesthesia, breathing just well enough to stay pink when he was transferred to the warm humidity of the oxygen cot. His ribs sank in a little with each breath, and as the hours went by his tone became less, the efforts to breathe more evident and more distressing, and, finally, after a supreme effort the respiratory centre gave up, excessive carbon dioxide stimulation giving way to carbon dioxide narcosis, and about the 24th to 48th hour the baby passed quietly and acidotically away. The surgical repairs were usually intact but ventilation had not been equal to the allotted task.

The postoperative indications for intubation may be subdivided according to the major factor responsible for the respiratory difficulty (table I).

(a) Pulmonary insufficiency.
This is most acutely apparent in the baby with diaphragmatic hernia who has unilateral or bilateral pulmonary hypoplasia, together with a poorly functioning hemidiaphragm, postoperatively a pleural drain tube predisposing to mediastinal flap and, not infrequently, pneumonic consolidation and collapse.

Not uncommonly following repair of an oesophageal atresia or the removal of an expanding congenital lung cyst, postoperative pneumothorax combines with pneumonia to produce inadequate ventilation, whilst closure of the distended protuberant abdomen after relief of intestinal obstruction and more particularly after repair of the severe exomphalos, leaves the high diaphragm effectively splinted (fig. 1).

The magnitude of ventilation in the average normal neonatal baby is of the order of 20 ml
and of this approximately 8 ml represents deadspace air, whilst 12 ml is used for alveolar ventilation.

Figure 2 demonstrates the ventilatory defect incurred by the neonatal baby who has had a repair for diaphragmatic hernia. Ventilation is defective because of left pulmonary agenesis, varying degrees of right pulmonary collapse and infection, and poor diaphragmatic function. The effective deadspace is increased by a poor ventilation/perfusion ratio in the right lung, and to the effects of anoxia are added those of an increasing carbon dioxide tension—acidosis, narcosis and increased respiratory muscular effort. The resultant strain on the baby’s circulation is compounded by the mediastinal flap arising from the presence of a pleural drain tube. By the simple act of passing an endotracheal tube the anatomical deadspace is reduced by 5 or 6 ml, and this may be dramatically lifesaving in a baby whose needed alveolar ventilation is only 12 ml.

Case 2. A.B., aged 2 hours, was admitted to hospital in a moribund condition with a diagnosis of diaphragmatic hernia. Operation was carried out immediately. Postoperatively respiration was inadequate and a nasotracheal tube was inserted. He remained slightly cyanosed but made strong respiratory efforts; the capillary blood pH was 7.02, and Pco₂ 76 mm Hg. Next day he appeared greatly improved. The pH was 7.15 and Pco₂ 55 mm Hg. Two days later, his colour was normal, the right lung was completely expanded, and there was some expansion of the left lung also. The pH was 7.29 and Pco₂ 42 mm Hg. He was extubated, and over the next 2 weeks the left lung fully expanded.

The trachea should be intubated as soon as it becomes apparent that the baby’s respiration is becoming an effort, e.g., when intercostal retraction is progressively increasing beyond minor degree. Procrastination of 24 or 48 hours may be fatal, anoxia and carbon dioxide narcosis having done irreparable damage.

Case 3. H.K., aged 3 days, was intubated 48 hours after the repair of her oesophageal atresia, having been in severe respiratory distress for the preceding 24 hours. The Pco₂ fell to normal almost immediately, but apnoeic attacks developed over the next day, and despite mechanical assistance to respiration, she died 6 days after being intubated. Aid had come too late.

(b) Obstruction associated with exudate.

In all the situations mentioned previously, lung infection and exudate will add obstructive difficulties. Intubation and regular aspiration may be carried out immediately postoperatively if evidence of moderate exudate in the lungs is present, or subsequently if respiratory inadequacy is becoming evident as secretions develop.

Case 4. A.C. had a tracheo-oesophageal fistula repaired on the second day of life. Eighteen hours later, it became apparent that he was unable to cope with the secretions arising from his bronchopneumonia. He was intubated, and treated with antibiotics and suction. Four days later, when the secretions had become clear and very small in amount, the endotracheal tube was removed. He made a full recovery.

(c) Pure mechanical obstruction.

Of the cases which fall into this group, two may be considered as examples.

Case 5. F.P. was a baby who had a large cystic hygroma removed from his neck. Postoperatively, pharyngeal and laryngeal extensions became oedematous, and respiratory obstruction necessitated urgent relief.

Case 6. S.D., aged 3, had a posterior fossa tumour removed, following which marked stridor due to laryngeal palsy became evident. The following day intubation became necessary. After an unsuccessful attempt at extubation on the 3rd day, the tube was removed on the 6th day. Since then there has been no evidence of stridor.

(d) Motor pathway failure.

Three postoperative neurosurgical patients represent this group: a neonate with subdural haematoma; an older child with an intracranial tumour; and a child with a cerebral abscess. All showed respiratory inadequacy and irregularity for periods from 24 hours to 14 days, two of these requiring artificial pulmonary ventilation as well as intubation.

Reversible Respiratory Disease (Non-operative).

Originally, non-operative indications were few but, with its usefulness becoming apparent, sufficient cases have now been presented for intubation for a second group to be included which corresponds closely to the postoperative group and to which the label reversible respiratory disease may be applied.

(a) Pulmonary insufficiency.

Case 7. M.B. was admitted during the first 24 hours of life with chest retraction and blood-stained exudate. Radiographs of the chest (fig. 3) confirmed a diagnosis of bronchomalacia and she fell into groups 2(a) and 2(c). Intubation partly relieved the respiratory distress by reducing deadspace and relieving tracheal obstruction, but lower respiratory tract obstruction remained and some retraction persisted. She was enabled to survive the urgent dyspnoeic phase.
Though no cases have so far been managed by us, it is likely that babies with hyaline membrane disease might similarly be able to survive the neonatal period of urgent respiratory distress.

(b) Obstruction associated with exudate.

This group which may yet prove to be the largest of all, consists of babies and young children with acute exudative obstruction from laryngo-tracheo-bronchitis or with bronchiolitis, usually of viral origin.

CASE 8. L.A., a 3-year-old child, developed bilateral pneumothorax following attempted tracheostomy for laryngo-tracheo-bronchitis. Pleural aspiration followed intubation, the child recovered and the tube was removed after 7 days (fig. 4).

(c) Pure mechanical obstruction.

More definitely falling into the obstructive group were: a case of obstructive goitre in a neonatal baby who had an indwelling tube for 8 days, followed subsequently by tracheostomy because of post-extubation oedema; a 4-year-old who presented with urgent upper respiratory tract obstruction from localized angioneurotic oedema of uncertain cause, possibly an insect bite; a 7-year-old child with thrombotic thrombocytopenic purpura and severe haemorrhage into the tongue; and a 3-year-old boy run over by a car, who presented with upper mediastinal obstruction of both venous and respiratory channels.

(d) Motor pathway failure.

A variety of patients were suffering from motor pathway failure, partial or absolute, and a high proportion of these required active mechanical ventilation. Central respiratory failure was evident in patients who had severe birth anoxia, intracranial tumour, meningitis, and malathione poisoning, and muscular failure in a baby with muscular dystrophy.
Radiograph of child with laryngotracheobronchitis. Bilateral pneumothorax followed unsuccessful tracheostomy. The nasotracheal tube is shown in place. The pneumothorax was subsequently aspirated and recovery followed.

Retained Tracheostomy Tube.

The third group, in which tracheal intubation is a stage in the decannulation of a persistent tracheostomy, is small but the patients and parents may be very grateful. Following the success of this manoeuvre described earlier, we met failure in a baby who at preliminary bronchoscopy was shown to have a very narrow trachea and intubation would have needed an unacceptably narrow tube, whilst a third baby of 18 months with a tracheostomy following laryngotracheobronchitis failed to decannulate despite intubation for 12 days.

Aid to Mechanical Ventilation.

This is an indefinite group which includes many of the former cases in whom artificial ventilation may be desirable. It will include some postoperative patients, particularly cardiac, and also an increasing number of patients with tetanus, poisonings, and other reversible diseases. Provided respiratory assistance is not indefinitely prolonged the technical ease of inflating the lungs of a baby by tube is much greater than by tracheostomy.

Taking all these patients together, it seems that reversible respiratory obstruction, or ventilatory inadequacy due to hypoplasia, pneumothorax, diaphragmatic splinting, pulmonary collapse or consolidation, is, in the presence of respiratory inadequacy, an indication for the passage of a nasotracheal tube with or without mechanical artificial ventilation. Excessive exudative obstruction may require tracheostomy, the management of which is a little easier, but exudate of lesser amounts associated with ventilatory defects may well be managed by intubation.

MANAGEMENT

Intubation.

Certain technical points in the procedure are important. Polyvinyl tubes are used in preference to rubber ones, as they mould at body temperatures to the respiratory tract contours and, because of this and their inherent non-toxicity, produce very little inflammatory reaction. They are autoclaved without metal connections to avoid splitting which otherwise occurs. In infants, intubation is performed without anaesthesia. For this we use intravenous atropine, methohexitone and suxamethonium. Respiratory obstruction as such does not contraindicate anaesthesia, provided that, with a knowledge of the pathology concerned, it is expected that it will be possible to inflate the patient's lungs. In patients who are severely dyspnoeic from obstruction due to laryngotracheobronchitis, for example, inflation can be readily carried out once they are paralyzed.

The nasal route is preferred to the oral for several reasons. In most cases it does not cause discomfort, the tube can be securely fixed to the nostril, and there is little danger of kinking and none of biting. In a small proportion of children under 5 years the nasal airway is too narrow to accept a nasotracheal tube without compressing it excessively. We have encountered this in four patients, in all of whom it has been possible to...
use an orotracheal tube. In all other patients, the largest tube which one would normally expect to fit the larynx when introduced orotracheally has been found to pass readily through one or other nostril.

Choosing the size of tube requires care. It is important that the tube is not so large as to exert excessive pressure on the mucosa overlying the cricoid cartilage, the narrowest part of the larynx. It is not easy to feel sensitively the resistance to the passage of the tube when introducing it into the larynx with Magill’s forceps and, if there is any doubt as to the relative sizes of glottis and tube, the tube is first passed orally, a loosely fitting size is determined, and then it is reinserted nasally.*

Humidification.

Humidification is essential if obstruction with viscid secretions is to be avoided. Provided the patient is nursed in a mist produced by an efficiently working nebulizer producing droplets predominately in the 0.5 to 10 micron range (Tovell and D’Ambruoso, 1962), obstruction will rarely occur. The mist may be delivered by an open method into an Isolette or oxygen tent, or by a semiclosed method to a T-piece of the Ayre’s type (fig. 5). When controlled ventilation is required, a Puritan nebulizer has been satisfactorily mated to a Bird respirator. The T-piece has much to commend it, as the operation wound does not become sodden, the baby’s heat-controlling mechanism is not interfered with, and the temperature of the inspired gases can be accurately controlled. However, the use of a long expiratory limb on the T is dangerous should the gas supply be accidentally cut off. For this reason, we now restrict the length of the expiratory limb to 1 inch, and use a sufficiently high flow of gases to ensure that there is no inhalation of room air.

The temperature at which the mist is delivered to the patient is important. We aim to maintain the temperature at the mouth of the endotracheal tube at 33 to 35°C, even in those being treated by induced hypothermia. If it falls below this figure, ciliary activity will be depressed, whilst raising it will cause the patient to feel uncomfortable. With the dilution control of the Puritan nebulizer set at 40 per cent and an oxygen inflow

* Corresponding sizes of the smaller Portex tubes do not differ in wall thickness or external diameter, whether they are marked “nasal” or “oral”. Consequently, we do not distinguish between the two, and are quite willing to pass an “oral” tube through the nose.

Fig. 5
Humidification by semiclosed method. Nebulized water vapour delivered with oxygen to Ayre’s T-piece. (Recently the expiratory tube has been reduced in length to 1 inch.)
of 4 to 8 l./min (equivalent to a total flow of air-oxygen mixture of 16 to 32 l./min), a 4-feet length of plastic tubing of ⅛-inch diameter will normally be sufficient to reduce the temperature of the gases issuing from the nebulizer from approximately 40°C to 34°C. Minor adjustments can be made by lengthening or shortening the tubing until the temperature is within the required range.

**Suction**

Suction is usually required quarter-hourly. Polyvinyl gastric feeding tubes are good suction catheters, passing more readily than rubber ones and with less trauma than polyethylene or nylon.

It is important that the nurse be quite certain that the sucker tubing is passed beyond the end of the endotracheal tube, and in this respect the management is less easy than is that of tracheostomy. Two babies, following oesophageal repair, had episodes of obstruction for just this reason and required urgent reintubation and resuscitation (fig. 6).

These patients are nursed in the Intensive Care Unit where medical assistance is readily available. On the two occasions of sudden complete obstruction, the immediate removal of the blocked tube has been lifesaving. Sometimes repeated acid-base balance determinations and estimations of arterial gas tensions are of helpful interest in following patient progress (table II).

**Extubation.**

Extubation is accomplished when the indication for intubation no longer exists. Secretions should be reduced to a small amount of thin mucus for 24 hours. If the conditions of respiratory inadequacy or obstruction seem factors no longer, the tube is removed and the child given a trial on his own. A proportion will show some distress in 1 to 8 hours as developing secretions are not adequately dealt with, or obstruction recurs, and will require temporary reintubation and suction. Second or even third intubations will occasionally be needed but need not give rise to despondency.

Ten children (20 per cent) required tracheostomy following the removal of the nasotracheal tube, three because respiratory assistance was to be maintained for a prolonged period, and seven because of persistent laryngeal oedema, obstruction or ulceration. Two children in particular merit special description as they developed unequivocal laryngeal obstruction following intubation.

**Case 9.** R.T., aged 2, underwent repair of a ventricular septal defect on May 1, 1964. Following this, he needed ventilatory assistance with a Bird ventilator through a 5-mm endotracheal tube until May 5. On May 8 he developed stridor and rib retraction, and tracheostomy was performed. He was decannulated on May 18, after which his voice remained very hoarse. He was discharged home on May 30, but readmitted on June 10 with a recurrence of complete heart block, which had initially been present for 5 days postoperatively.
### TABLE III

**Neonatal infants intubated.**

<table>
<thead>
<tr>
<th>Nature</th>
<th>Indication</th>
<th>Period</th>
<th>Comments</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Postoperative (15 cases)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oesophageal atresia with tracheo-oesophageal fistula (6)</td>
<td>Respiratory inadequacy; infection</td>
<td>3 days</td>
<td></td>
<td>Recovered</td>
</tr>
<tr>
<td></td>
<td>Respiratory inadequacy; infection</td>
<td>3 days</td>
<td></td>
<td>Recovered</td>
</tr>
<tr>
<td></td>
<td>Respiratory inadequacy; infection</td>
<td>5 days</td>
<td></td>
<td>Recovered</td>
</tr>
<tr>
<td></td>
<td>Respiratory inadequacy; infection</td>
<td>6 days</td>
<td></td>
<td>Died</td>
</tr>
<tr>
<td></td>
<td>Respiratory inadequacy; infection</td>
<td>7 days</td>
<td>Sclerema; required tracheostomy</td>
<td>Died</td>
</tr>
<tr>
<td></td>
<td>Respiratory inadequacy; infection</td>
<td>5 days</td>
<td></td>
<td>Recovered</td>
</tr>
<tr>
<td>Diaphragmatic hernia (3)</td>
<td>Respiratory inadequacy</td>
<td>2 days</td>
<td></td>
<td>Died</td>
</tr>
<tr>
<td></td>
<td>Respiratory inadequacy</td>
<td>3 days</td>
<td>Pco₂ 76 → 42 in 3 days</td>
<td>Recovered</td>
</tr>
<tr>
<td></td>
<td>Respiratory inadequacy</td>
<td>2 days</td>
<td></td>
<td>Recovered</td>
</tr>
<tr>
<td>Exomphalos (2)</td>
<td>Respiratory inadequacy</td>
<td>3 days</td>
<td></td>
<td>Recovered</td>
</tr>
<tr>
<td></td>
<td>Respiratory inadequacy</td>
<td>15 days</td>
<td>2 months premature</td>
<td>Died</td>
</tr>
<tr>
<td>Jejunal atresia</td>
<td>Apnoea</td>
<td>4 days</td>
<td>2 months premature; Bird respirator</td>
<td>Died</td>
</tr>
<tr>
<td>Cystic hygroma</td>
<td>Upper respiratory obstruction</td>
<td>2 days</td>
<td>Intubated late</td>
<td>Died</td>
</tr>
<tr>
<td>Subdural haematoma</td>
<td>Apnoea</td>
<td>1 day</td>
<td>Bird respirator</td>
<td>Recovered</td>
</tr>
<tr>
<td>Patent ductus; coarctation</td>
<td>Respiratory inadequacy</td>
<td>4 days</td>
<td>Bird respirator</td>
<td>Died</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Non-operative (5 cases)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atelectasis following Caesarean section</td>
<td>Respiratory inadequacy</td>
<td>2 days</td>
<td>Bird respirator</td>
<td>Died</td>
</tr>
<tr>
<td>Goitre</td>
<td>Upper respiratory obstruction</td>
<td>8 days</td>
<td>Followed by tracheostomy, 2 days</td>
<td>Recovered</td>
</tr>
<tr>
<td>Bronchomalacia</td>
<td>Respiratory inadequacy; obstruction</td>
<td>12 days</td>
<td></td>
<td>Recovered</td>
</tr>
<tr>
<td>Laryngeal agenesis</td>
<td>Respiratory obstruction</td>
<td>6 days</td>
<td>Followed by tracheostomy</td>
<td>Died</td>
</tr>
<tr>
<td>Birth anoxia</td>
<td>Respiratory inadequacy</td>
<td>6 days</td>
<td></td>
<td>Recovered</td>
</tr>
</tbody>
</table>
On June 18 cardiac arrest occurred. After resuscitation he remained unconscious, and died 2 days later. Cross-sections taken through the larynx and trachea (fig. 7) show an area 1.5 cm below the cords in which the lumen narrows from 0.6 cm to 0.3 cm over a distance of 0.3 cm. In this region the submucosa shows an increase in fibrous and organizing granulation tissue. In retrospect, it appears that the endotracheal tube used was too large.

Fig. 7
Cross-sections through larynx and trachea of 2-year-old child. The 4th section from the left shows narrowing to 3 mm diameter following intubation. The tracheostomy scar can be seen at the level of the 6th and 7th sections.

CASE 10. S.R. had his oesophageal atresia repaired at the age of 3 months. Following this, respiratory inadequacy developed which was relieved by the insertion of a 3.5-mm tube. Exubration was unsuccess-
fully attempted on the 4th day, and at this stage a small ulcer was noted to be present between the arytenoid cartilages. The tube came out accidentally on the 8th day, and it was found that only a 3-mm tube could be reinserted, and that with great difficulty. Tracheostomy was performed. Laryngoscopy on three occasions after this revealed adducted cords (despite complete paralysis with suxamethonium), and a probe could be passed no more than a short distance beyond them. He died from bronchopneumonia 5 months later. Postmortem examination showed a laryngeal web, almost certainly congenital in type, occluding all the lumen of the larynx except for a crescent-shaped area posteriorly, through which a 3-mm probe could be passed. The part played by the indwelling tube in altering the characteristics of this web is a matter for conjecture.

These two cases have caused some concern about the local effects of the indwelling tube. When the larynx is inspected after extubation it is almost invariably found to be reddened, and it is quite common for the patient to have a hoarse voice for a few days. Laryngoscopy at a later date, however, has always revealed a normal appearance of the mucous membrane, even in two cases in whom ulceration had previously been present. The single exception to this was a severely burnt patient who developed *Pseudomonas pyocyaneus* septicemia, the laryngeal ulcer here being part of a generalized process, with ulceration spread throughout the skin and mucous membranes of the body. Apart from the cases quoted, no patient has shown any pro-
longed disability following extubation.

A tabulated summary of the first fifty cases dealt with in this way for periods of more than 24 hours is appended (tables III and IV). Twenty-nine babies and children underwent intubation following operation for congenital defects in neonates, and for cardiac and intracranial lesions. In a further twenty-one intubation was performed for a variety of non-operative conditions, includ-
ing pulmonary infections, respiratory obstruction, poisoning, and central and peripheral respiratory failure. In all, twenty neonatal babies were involved during this period of fifteen months. Of the total number, twenty-nine recovered and twenty-one died, but these figures are of little importance as each patient must be individually assessed and managed accordingly.

**DISCUSSION**

Whether the management of respiratory inade-
quacy has been significantly affected by naso-
tracheal intubation is probably impossible to verify statistically. Certain salient points, how-
ever, emerge from the study of respiratory diffi-
culty in infants and children, particularly from one's experience with the postoperative manage-
ment of neonatal babies. Firstly, no matter how expert the surgical team, in the absence of respira-
tory assistance there has been a considerable mortality in the first 48 hours following surgery upon the neonatal baby for congenital anomalies in the abdomen, and more particularly the thorax (McDonald, 1964). The problem is one of too few functioning alveoli, and too large a deadspace relative to the tidal volume achieved. Secondly, there is unquestionably a high incidence of re-
tained tracheostomy tubes in babies (Venables, 1959) which has been responsible for the avoid-
ance of this procedure in many babies who other-
wise would have benefited from the decreased
TABLE IV
Other babies and children intubated.

<table>
<thead>
<tr>
<th>Nature</th>
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<th>Indication</th>
<th>Period</th>
<th>Comments</th>
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<td><strong>Postoperative (14 cases)</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Oesophageal atresia (2)</td>
<td>4/12</td>
<td>Repair breakdown; secretions</td>
<td>2 days</td>
<td></td>
<td>Recovered</td>
</tr>
<tr>
<td></td>
<td>3/12</td>
<td>Repair breakdown; respiratory inadequacy</td>
<td>8 days</td>
<td>Laryngeal web; tracheostomy</td>
<td>Died</td>
</tr>
<tr>
<td>Ventricular septal defect; atrial septal defect</td>
<td>6</td>
<td>Pulmonary collapse</td>
<td>4 days</td>
<td>Bird respirator; tracheostomy</td>
<td>Recovered</td>
</tr>
<tr>
<td>Ventricular septal defect</td>
<td>2</td>
<td>Respiratory inadequacy</td>
<td>3 days</td>
<td>Tracheostomy after 4 days</td>
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<td>Fallot (3)</td>
<td>4</td>
<td>Respiratory inadequacy</td>
<td>4 days</td>
<td></td>
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<tr>
<td></td>
<td>2</td>
<td>Respiratory inadequacy</td>
<td>1 day</td>
<td>Laryngeal stenosis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>Respiratory inadequacy</td>
<td>2 days</td>
<td>Tracheostomy</td>
<td>Recovered</td>
</tr>
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<td>Cerebellar haemangioma</td>
<td>13</td>
<td>Respiratory inadequacy</td>
<td>14 days</td>
<td>Curling's ulcers</td>
<td>Recovered</td>
</tr>
<tr>
<td>Cerebral abscess</td>
<td>8</td>
<td>Cardiac arrest; respiratory inadequacy</td>
<td>4 days</td>
<td></td>
<td>Recovered</td>
</tr>
<tr>
<td>Posterior fossa tumour (4)</td>
<td>3</td>
<td>Respiratory inadequacy; laryngeal palsy</td>
<td>6 days</td>
<td>Tracheostomy, 1 month</td>
<td>Recovered</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Respiratory inadequacy</td>
<td>14 days</td>
<td></td>
<td>Died</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Laryngeal palsy</td>
<td>5 days</td>
<td></td>
<td>Recovered</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>Respiratory obstruction; secretions</td>
<td>5 days</td>
<td></td>
<td>Recovered</td>
</tr>
<tr>
<td>Burns; septicaemia</td>
<td>2</td>
<td>Laryngeal oedema</td>
<td>4 days</td>
<td>Tracheostomy; ulcerated larynx</td>
<td>Died</td>
</tr>
<tr>
<td><strong>Non-operative (16 cases)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oesophageal atresia with tracheo-oesophageal fistula (2)</td>
<td>7/12</td>
<td>Retained tracheostomy</td>
<td>5 days</td>
<td></td>
<td>Recovered</td>
</tr>
<tr>
<td></td>
<td>6/12</td>
<td>Pneumonia; tracheal softening</td>
<td>6 days</td>
<td></td>
<td>Recovered</td>
</tr>
<tr>
<td>Laryngo-tracheo-bronchitis (2)</td>
<td>3</td>
<td>Upper respiratory tract obstruction; failed tracheostomy</td>
<td>7 days</td>
<td></td>
<td>Recovered</td>
</tr>
<tr>
<td></td>
<td>18/12</td>
<td>Retained tracheostomy</td>
<td>12 days</td>
<td>Re-tracheostomy</td>
<td>Recovered</td>
</tr>
<tr>
<td>Bronchiolitis (3)</td>
<td>6/12</td>
<td>Respiratory obstruction; secretions</td>
<td>2 days</td>
<td></td>
<td>Recovered</td>
</tr>
<tr>
<td></td>
<td>3/12</td>
<td>Respiratory obstruction; secretions</td>
<td>1 day</td>
<td>Bird respirator</td>
<td>Died</td>
</tr>
<tr>
<td>Motor car accident; quadriplegia</td>
<td>4</td>
<td>Respiratory failure</td>
<td>8 days</td>
<td>Bird respirator</td>
<td>Died</td>
</tr>
<tr>
<td>Motor car accident; laryngeal oedema</td>
<td>3</td>
<td>Upper respiratory tract obstruction</td>
<td>3 days</td>
<td></td>
<td>Recovered</td>
</tr>
<tr>
<td>Angioneuretic oedema</td>
<td>4</td>
<td>Upper respiratory tract obstruction</td>
<td>3 days</td>
<td></td>
<td>Recovered</td>
</tr>
<tr>
<td>Tongue haemorrhage</td>
<td>7</td>
<td>Upper respiratory tract obstruction</td>
<td>2 days</td>
<td></td>
<td>Died</td>
</tr>
<tr>
<td>Meningitis; eplepsy</td>
<td>7</td>
<td>Respiratory inadequacy</td>
<td>2 days</td>
<td></td>
<td>Recovered</td>
</tr>
<tr>
<td>Salicylate poisoning</td>
<td>16/12</td>
<td>Pneumonia; cardiac arrest</td>
<td>6 days</td>
<td></td>
<td>Died</td>
</tr>
<tr>
<td>Malathione poisoning</td>
<td>6</td>
<td>Respiratory obstruction; coma</td>
<td>2 days</td>
<td></td>
<td>Recovered</td>
</tr>
<tr>
<td>Laryngeal foreign body</td>
<td>3</td>
<td>Cardiac arrest</td>
<td>3 days</td>
<td>Bird respirator</td>
<td>Recovered</td>
</tr>
<tr>
<td>Muscular dystrophy</td>
<td>16/12</td>
<td>Cardiac arrest; pneumonia</td>
<td>2 days</td>
<td>Bird respirator</td>
<td>Died</td>
</tr>
</tbody>
</table>
deadspase and effective bronchial suction which tracheostomy provides. Intubation of the trachea, originally for brief periods of several hours and later for longer periods of up to fourteen days, has to a large extent overcome this problem and, on the evidence of past experience, has probably saved the lives of several babies. Because of the apparent success achieved, a wider group of patients, postoperative and non-operative, children as well as infants, has undergone intubation for a variety of reasons, and these have been spared an unnecessary tracheostomy.

This has not been achieved without cost as consideration of cases 9 and 10 will show. When it becomes apparent that some form of artificial airway is necessary, several factors should be considered before deciding between tracheostomy and intubation. If the expected natural course of the respiratory disability is but a few days and secretions are not gross, intubation is preferable to tracheostomy, particularly in the young child for whom the dangers of retained tracheostomy and pneumothorax are considerable. Furthermore, intubation is technically more easily performed, and the very ill patient is less disturbed by it. Positive pressure ventilation is more readily managed in the intubated child, as leakage of air through the larynx can be a major factor in the small patient where a cuffed tracheostomy tube is impracticable.

On the other hand, if the need for artificial airway is expected to be prolonged, or if secretions are considerable, tracheostomy is to be preferred. Suction is more readily carried out through a tracheostomy, especially if it is desirable to enter the left main bronchus, whilst a blocked tube is less liable to occur. The nasal airway may be so narrow that unless oro-tracheal intubation, with all its disadvantages, is feasible, tracheostomy is mandatory. In some conditions of respiratory obstruction intubation may be very difficult or impossible, particularly in Haemophilus influenzae epiglottitis (in which the cords cannot be visualized) or in subglottic stenosis. The possibility of actually producing subglottic stenosis has to some extent coloured our attitude to intubation in patients with laryngotracheobronchitis for prolonged periods, though many have had tracheostomies performed after preliminary intubation and anaesthesia. Finally, it is of some practical importance that the intubated child is necessarily confined to bed, whereas a child with a tracheostomy performed for respiratory obstruction may be able to play with others in the ward.

After consideration of the factors involved, and having determined upon intubation, due care by an enthusiastic and attentive nursing staff produces some gratifying results.

ACKNOWLEDGMENTS
Our thanks are due to the Director of Anaesthesia, Dr. Margaret McClelland, and to the members of the surgical, medical, and anaesthetic staff of the Royal Children's Hospital, Melbourne, whose original interest in this procedure has led to its present satisfactory development; also to Miss Elizabeth Jaffray and her nursing staff in the Intensive Care Unit whose attentive care makes the procedure possible.

REFERENCES
O'Dwyer, J. (1885). Two cases of croup treated by tubeage of the glottis. N.Y. med. j., 42, 605.

L'INTUBATION NASO-TRACHEALE PROLONGEE: REVUE DE SON UTILISATION DANS UN HOPITAL PEDIATRIQUE

SOMMAIRE
La valeur de l'intubation naso-trachéale prolongée chez certains bébés et enfants présentant une insuffisance respiratoire réversible a été reconnue en conséquence du traitement post-opératoire de nouveau-nés. Dans certains cas, la technique peut être utilisée à la place de la trachéostomie, et elle peut être efficace quand la trachéostomie pourrait être déconseillée. Sa valeur consiste en: (1) la facilité et la rapidité d'exécution par ceux qui sont habitués à passer des sondes endotrachéales; (2) la réduction effective de l'espace mort quand celui-ci est critique; (3) son utilité dans le contrôle des sécrétions modérées; (4) la possibilité de shunter les obstructions des voies respiratoires supérieures, en particulier quand la nature des obstructions peut être telle qu'elle rende la trachéostomie dangereuse; (5) l'utilisation effective de la ventilation contrôlée quand celle-ci est indiquée, spécialement chez le bébé; (6) l'élimination de certains des risques de la trachéostomie, surtout chez le nouveau-né.
It is fascinating to read again the story of curare and for the writer it was a pleasant exercise to retrace much of the ground covered during research into the intriguing history of this substance for a historical section of a thesis written twenty years ago. Within these pages there is, however, a deal that is new to the writer and Dr. Bryn Thomas has produced a valuable work of reference.

What formidable characters make up the dramatis personae of this saga—Raleigh, the Schomburgk brothers, Humboldt, heroic Jesuit missionaries and, last but not least, the more than life-size eccentric Charles Waterton. Add to this formidable list names of famous physiologists who have unveiled so many of the mysteries of myoneural transmission with the aid of curare and it is not difficult to understand the attraction of the subject for a broad spectrum of medical men, biologists and historians.

Mysteries remain. Why did Brodie so ignore Waterton and vice versa? Waterton was incorrigibly intolerant of those he regarded as "arm-chair scientists" but this hardly explains the mutual failure to recognize each other by two who combined in pioneering experiments with curare. Waterton suggested pulmonary ventilation as the only effective antidote to curare twelve to thirteen years before the Brodie experiments. Brodie carried out the crucial experiment on the donkey with the assistance of Professor Sewell in 1814, two years after similar experiments with rabbits. He only gave Waterton the acknowledgment of having supplied the curare. Although Waterton's notes on the antidote were only published in his classical book, Wanderings in South America, in 1825, Dr. Bryn Thomas suggests that these notes were made ten or fifteen years before.

It may be so, but the writer knows of no proof, except an acceptance of Waterton's patent honesty. If it is so, he could have suggested Brodie's experiments and the latter's failure to acknowledge this could have caused the strain in friendly relationship. Medical history is bespattered with similar conflicts, even in anaesthesia: for example the ether controversy between Jackson and Morton, or the chloroform dispute between Waldie and Simpson. This arises probably because, when the stage is set and the time is ripe, discoveries are usually generated in more than one receptive and fertile mind.

Cecil Gray

BOOK REVIEWS


Three chapters, of which the first and last refer respectively to the pathophysiology of the kidney and liver in shock, comprise this short book, whose title is mildly irrelevant to its contents. The middle chapter, by Bull of Birmingham, presents a background of clinical physiology directed toward the treatment of haemorrhage or trauma in patients.

Brun and Munck, of Copenhagen, give a usefully up-to-date account of clinical methods of measuring renal function (including bloodflow), discuss kidney function in shock and, together with the histopathology, in acute renal failure. They conclude that shutdown is not caused by renal hypoxia, and that in acute renal failure the measured reductions in bloodflow and oxygen uptake are not primary factors. The apparent reduction in the oxygen demand of the kidney in haemorrhagic shock is of particular note.

Smith and Veragut, from Los Angeles, present detailed findings relevant to the liver in shock, established mainly in the dog laboratory; they have to admit that "little specific information is available regarding hepatic circulatory changes during shock in man". Especially interesting is the high correlation shown in man between the "therapeutic" administration of sympathomimetic amines and the postmortem identification of central hepatic necrosis.

Review articles of this type (total references, 297) are clear recommendations to anaesthetists participating in resuscitation, and certainly for all "accident service" libraries.