Dr. Yandell Henderson's article "The Prevention and Treatment of Asphyxia in the New-Born" [1] is a friendly challenge to the physician to do better work in resuscitation than he has done in the past, or to yield to the supremacy of the fire department.

If the physician is to be more successful in meeting these opportunities to save life, he should bring into play his specialized knowledge of internal and external respiration and place himself in a position wherein this knowledge may be applied by becoming intimately familiar with the anatomy of the upper airway, pharynx, hypopharynx and larynx as it appears with and without its reflexes. Familiarity with this field may readily be acquired in the anesthetized patient, in the cadaver, and, where the baby is concerned, in a new-born still-born child.

Dr. Henderson has covered the field of internal respiration with the thoroughness that is characteristic of all his work. It merely remains to devise means to employ to the best advantage the principles he has laid down regarding the life-saving value of a mixture of oxygen and carbon dioxide.

The only originality I claim in the suggestions that follow is in the facilities I provide for the practical application of principles which every physician understands: namely, a simple practical means of inspecting and preparing the respiratory tract for the deliberate and exact introduction into it, at a point beyond the possibility of anatomic obstruction, of a measured volume of a known mixture of oxygen and carbon dioxide under the most sensitive conditions of manometer pressure at our disposal.

Several months ago, during the course of investigation and experimentation directed to improving and simplifying intratracheal anesthesia, I [2] was struck by what seemed to be the haphazard manner in which the airway of the new-born infant is cared for. I said as much to an obstetric friend, while on a case, and suggested that some sort of routine toilet of the respiratory tract should be practiced and
taught; that this toilet should be carried out by direct vision of the mouth and throat, providing facilities for laryngoscopy and intubation, as required. The obstetrician, who is a leader in his specialty, replied that he would give a good deal if he could be shown how to expose a baby's larynx easily and without trauma.

Dr. Yandell Henderson's article then appeared, and to the problem of providing a suitable toilet for the airway of the new-born was added the necessity for devising a practical application of oxygen and carbon dioxide therapy.

There appears to be some difference of opinion among observers as to the amount of amniotic fluid and detritus normally present in the new-born infant's respiratory tract. Johnson maintains that normally the mouth, the pharynx, the trachea, and the bronchi up to the second bifurcation are filled with amniotic fluid; the birth over the perineum, with the accompanying compression of the chest, squeezes most of this fluid out of the airway, through the mouth and the nose. It is a common experience to witness this discharge on the delivery of the head.

Breech presentation, version, and cesarean section, in which compression of the chest has not taken place, leave the child's respiratory tract filled with fluid, much of which is inhaled, unless immediately expelled by artificial means. The lungs of infants dying of pneumonia immediately after birth show, on section, bronchioles and alveoli filled with amniotic fluid and epithelial cells.

If the inhaled fluid is sterile, it appears to be absorbed in moderate quantities, without much subsequent disturbance.

Postmortem examination of children who have breathed or who have received mouth-to-mouth insufflation does not show fluid in the mouth or trachea at autopsy for the reason that this has been expelled by manipulation or blown into the finer air radicles by the operator, who, it is easily demonstrable, develops a positive pressure of from 50 to 75 mm. of mercury. Stethoscopic auscultation, under intratracheal insufflation, shows such a chest to be full of large, moist râles.

No attempt at artificial respiration should ever be made until the mouth and the throat have been sucked free of fluid and until direct vision confirms the freedom of the airway.

As we look back over the road which has been traversed so far, it would seem that the problem of scientific artificial respiration, both in infants and in adults, revolves on the ease with which the larynx may be exposed and intubated.

To ignore this fact and the necessity of this technic is to discount the truth that the glottis is a comparatively small elastic doorway through which all respired gases must of necessity pass, and that this doorway, in an infant whose reflexes are present, is nothing but a tiny slit about 1 to 2 mm. wide by 6 to 8 mm. long during inspiration, and more sensitive to reflex irritation than the cornea.
Fortunately, the sicker the baby, the more his reflexes are obtunded, the more relaxed becomes his respiratory door. The glottis, which will scarcely admit a 2 mm. tube with reflexes present, will accept with ease a 4 mm. tube in a state of asphyxia.

It is fair to assume that the state of the reflexes of a baby's larynx is a measure of the need of intratracheal intubation.

If a baby has a relaxed, open larynx, intubation should be done. The baby whose larynx offers resistance to intubation will do very well with artificial respiration by pharyngeal insufflation.

The chief resistance to the popularization of laryngoscopy appears to be the uncertain functioning of the usual delicate electrical equipment commonly used for laryngeal and bronchial work. Bronchoscopy requires small lights, large batteries and wiring. Laryngoscopy at the bedside, in the office, and in the ordinary emergency is well covered by ordinary pocket facilities, and, furthermore, permits of the use of the large lamp which seldom burns out.

The author's baby speculum was constructed on data furnished by the new-born still-born infant and in babies in whom postpartum deaths had occurred within a few hours. The weight of the babies observed varied between 6 and 10 pounds (2.7 and 4.5 Kg.). The distance from the upper gums to the glottis averaged 2 1/2 inches (6.3 cm).

Exposure of the Larynx

The soft, yielding tissue of the new-born child, the complete relaxation that accompanies the asphyxia of the new-born, the absence of teeth, the relatively large mouth and the short distance between the gums and the glottis provide ideal conditions for easy and nontraumatic exposure of the glottis.

As the reflexes reappear, a perfectly simple exposure becomes much more difficult. It may be reiterated that the conditions favoring intubation are in direct proportion to the need, and that laryngeal reflexes return with the activity of the respiratory center.

To expose the larynx, the baby is made to lie on a table, flat on its back; the head is moderately extended, the chin being kept in the midline. The lips are separated, and the mouth is opened with the thumb and forefinger of the right hand. The illuminated speculum is made to pass gently over the tongue until the epiglottis is exposed. The hypopharynx is now in full view; and secretion present should be removed by suction. The lip of the laryngoscope is now made to pass just beneath the epiglottis. Care must be taken that the lip of the laryngoscope does not pass over the larynx, as the distance between the epiglottis and the glottis is very short. In fact, it is sometimes practical to lift the tongue, exposing the epiglottis and the glottis simultaneously.

If, during the examination, no reflex activity of the glottis is observed, the intratracheal suction tube (fig. 2A) should be passed between the cords and into the trachea to clear it of fluid. If there is still no
laryngeal reflex or only a very faint response, the intra-tracheal insufflation tube (fig. 2D) should be inserted, and oxygen and carbon dioxide allowed to flow into the trachea. Partial or complete closure of the intratracheal tube orifice (fig. 2DT) will distend the lungs to a degree to which the manometer (fig. 1C) is set. When the laryngeal reflexes have returned and have become active, the tracheal tube should be removed, and the pharyngeal tube substituted.

Where oxygen and carbon dioxide are used for stimulation of depressed respiration, the pharynx should be exposed and cleared, as noted. The reflexes having been found active, intubation is dispensed with, and the pharyngeal tube is employed.

It is recommended that the respiration be interrupted by placing the thumb on the intratracheal tube every fifteen to twenty seconds. It is to be remembered that the oxygen or carbon dioxide in the trachea and the bronchi, even though under little pressure, is absorbed by diffusion.

The principles of scientific artificial respiration may be carried out by extremely simple apparatus, improved as follows:

A suitable laryngoscope for the exposure of the field (nothing is finer than the Jackson instrument; Dr. Jackson urged the treatment of the newborn which I now describe in his book on bronchoscopy some years ago).

A source of suction: water, electricity or steam, or the surgeon sucking one end of the catheter.

A metal tube with a smooth end, measuring not more than 4 mm., or three-sixteenths inch, in external diameter.

A Y or T tube, the vertical arm being extended by a length of glass or rubber submerged in water for a vertical depth of 8 inches.

A low pressure oxygen tank, or the surgeon's breath.

I have employed the foregoing equipment and have demonstrated its usefulness. The chief difficulty experienced was the need of too many assistants: the oxygen had to be hunted up and connected. It was often found to be only partly filled. The improvised manometer, which was a large stoppered tube, had to be held by some one. There was the danger of the baby aspirating water out of the manometer, when the gas pressure was stopped. The intermittent distention of the lung meant the shutting off of the tank or the withdrawal of the intratracheal tube.

Believing that no pains should be spared to perfect an assembly whose proper functioning might mean the life or death of a patient, I determined to eliminate all electrically driven apparatus, rubber parts, and spring or mercury manometers which might fail through accident.
The equipment now assembled is a one-man outfit, and consists of the following:

1. Small tanks of oxygen and carbon dioxide which are easily portable and may be stored are employed (fig. 1A).

2. The gas in these small tanks is under a high pressure, necessitating a reducing valve with a pressure gage, the pressure gage indicating the amount of gas remaining in the tank (fig. 1B).

3. A specially constructed water manometer has been designed. This manometer has a range that is sufficient for adult artificial respiration (40 mm. of mercury).

This manometer is attached directly to the reducing valve. The pressure is set by filling the glass container with water through a funnel at the top (the funnel serves as an air vent) drawing off through a petcock at the bottom, until a suitable depth of water obtains. (Mercury is thirteen times as heavy as water. One inch of mercury equals 13 inches of water. Therefore, one inch of water equals, approximately, 2 mm. of mercury.)

Aspiration from the manometer is prevented by the hollow metal tube, forming the support of the gage, into which aspirated fluid will collect. The manometer acts as a safety valve and, furthermore, indicates by the depression of the fluid in the inner tube the volume of gas delivered.

4. The suction outfit (fig. 3) develops a negative pressure of from 40 to 60 mm. of mercury and is provided with a specially curved suction tube (fig. 2B) and an intratracheal suction tube (fig. 2A).

5. The intratracheal tube (fig. 2D) is a right angle, hollow tube, open at three points, $S T M$. $S$ is connected directly with the manometer. The opening $T$ is regulated by the thumb of the operator. When the tube is intubated (the tip, which is 1 1/2 inches long, consisting of 4 mm. of tubing) gas flowing from the manometer to $S$ escapes from $T$. When the thumb of the operator closes $T$, gas flows into the trachea until the thumb is removed, at a pressure set by the depth of water in the manometer. Removal of the thumb from $T$ allows expiration, by virtue of the resilience of the chest wall. The air valve $T$ acts as an additional safety valve against pressure. Gas can enter the lung only when this opening is closed by the thumb.

6. The pharyngeal insufflation tube (fig. 2E) is used for patients with active or returned reflexes who need the stimulating effect of carbon dioxide but do not require intubation. This tube is made of heavy metal, so that a soft, rounded edge may be had. Oxygen enters at $E$, and is delivered deep into the tube. A thumb control is provided, as in the
intratracheal tube. In this case, however, the greater part of the oxygen and carbon dioxide flows into the pharynx, even though the thumb control is open, for the thumb opening is much smaller than the tube. The opening in the flange B is for a catheter (number 14 French), which should be passed into the stomach, when this tube is used, so that oxygen insufflated, finding its way into the stomach, will not distend this organ and interfere with the respiratory efforts.

7. The laryngoscope (fig. 2C), already referred to, is of the pocket flashlight type, with a large handle, lamp and detachable speculum, which may be boiled with the lamp in place, or sterilized in alcohol before used.

The assembly described is protected by a container. This container permits transportation and offers the facilities of a stand and table, when in use.

After use, all instruments are cleaned, sterilized, and put away in a sterile container, ready for immediate use.

A further report of the technic described will be submitted as experience with asphyxia neonatorum, gas poisoning and cases of drowning are observed.

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Figures
Fig. 1. Oxygen-carbon dioxide tank, reducing valve and author's water manometer.

Fig. 2. Instrument equipment: A, Intratracheal suction tube; B,
pharyngeal suction tube; C, baby illuminated laryngoscope; D, intratracheal insufflation tube; E, pharyngeal insufflation tube.

Fig. 3. "Little Sucker" for hand suction.
Fig. 4. Author's water manometer for measuring pressure, volume and negative pressure.
Fig. 5. Author's resuscitation apparatus ready for use. The case opens to form a temporary stand, one side of which supports a collapsible tray for sterile instruments.

Footnotes