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from the Air Passages, 3 3**

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REMOVAL OF FOREIGN BODIES FROM THE
AIR PASSAGES.*

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The entrance of a foreign body into the larynx is at once the signal for violent expulsive efforts, and in the majority of instances voluntary extrusion is accomplished. Should the object, however, pass the vocal cords, the route to the bifurcation of the trachea is free and unobstructed. At the bifurcation, as the right bronchus is larger and turns at a less abrupt angle to reach the root of the lung, the body is more likely to fall into its lumen, although this result is by no means positive.† If the object is of irregular shape it will not closely fit, and violent efforts at coughing may still loosen it. It may, however, be arrested in its reverse course at the vocal cords. The violence of the efforts, and the interference with the air supply, unfortunately make inspiratory suction as sudden and nearly as intense as expiration, and the offending object may be sucked further into the air passages. The position of final fixation will depend upon these efforts and upon the size and character of the foreign body. The degree of air hunger will depend upon the amount of blockade. Should the entire main bronchus be obstructed, one-half

* Read at the Fifty-second Annual Meeting of the American Medical Association, in the Section on Surgery and Anatomy, and approved for publication by the Executive Committee of the Section: Drs. W. J. Mayo, H. O. Walker and A. J. Ochsner.

† Crile: Surgery, Respiratory System, 2d Edition, p. 92.

the respiratory tract will be shut off and the dyspnea becomes extreme. Unfortunately, the physician is rarely at hand and immediate professional measures of relief can not be instituted. The majority of these accidents occur in children; consequently, it is well to instruct parents as to the procedures that should be adopted. The rule as ordinarily taught is to the effect that inversion of the child is unsafe, since the object may become blocked within the larynx. As the body has, however, entered by this route, and as it is the one that must be taken in any voluntary expulsion, it is probably the safest domestic practice that can be instituted and may prevent the object from being sucked still lower in the bronchus. An exaggerated prone Trendelenburg position may be maintained until the arrival of the surgeon. Succussion of the individual and vomiting have occasionally dislodged the body. Coughing should be encouraged, but the violence of inspiratory movements should be restricted as far as possible. Brodie reports the case of an adult in whom a half sovereign had reached the bifurcation of the trachea. By inversion of his body in the prone position, and succussion, he was able, after six weeks, to dislodge the offender by coughing, and full recovery ensued.

If the arrest has taken place at the vocal cords, a laryngoscopic examination will probably reveal it, and it may be extracted by forceps or by laryngotomy. In splitting the thyroid cartilage and opening the larynx, care should be taken to keep directly in the median line and to avoid injury of the arytenoid cartilages and muscles. Cocain should be applied to the mucous membrane both before and during the operation, to prevent reflex inhibitory influences upon the heart.

If an *x*-ray apparatus is at hand, and the foreign body is one which is impenetrable to these rays, as coins, nails, etc., the location may sometimes be accurately

determined by making shadowgraphs at different angles. Unfortunately, the distress is so urgent and extreme that it is difficult to induce the child to remain quiet long enough to obtain such a shadow unless ether is administered; still, the *x*-ray representation fills a most important place in both acute and chronic blockades of the air passages.

With children, beads, beans, portions of whistles and toys are common intruders.¹ Hard bodies will probably imbed themselves and do not offer much opportunity of being seized by forceps. Vegetable substances are likely to swell from the moisture if they remain long *in situ*, and are, therefore, difficult to dislodge. In one of my fatal cases one-half of the brown shell of a chestnut was drawn far down into the subdivision of a bronchus.

It is important that the history should be reliable, and when a body has been swallowed, close investigation is necessary to determine whether the object has entered the air passages, and secondly, its location. Of course, there are many cases where the symptoms are unmistakable, but when in doubt a most careful diagnosis should be made. A young child not infrequently has a foreign body in its mouth; is seized with violent coughing as the body attempts to enter the larynx, and yet it passes into the stomach. Not a few tracheotomies have been performed in the search for such objects which have later been passed per rectum; consequently, it is unwise to operate in the absence of definite symptoms. Moreover, many a child has been apparently choked with a toy which was supposed to have been swallowed and which has ultimately been found in the corner of the nursery. I have myself witnessed in the practice of one of our most prominent surgeons, a tracheotomy with prolonged search, in which case the article

1. Poulet : Foreign Bodies, 1880, vol. II, p. 22.

which had supposedly been swallowed was later found in the pocket of the child, and an examination of the lungs (which should have been made previous to the operation, but which was instituted afterwards) developed the fact that the dyspneic symptoms were due to double pneumonia from ordinary causes.

Following impaction, the pain and the absence of respiratory movements will usually be found upon one side of the chest. The absence of vesicular murmur shows the interference to entrance of air, which will be followed later by dulness and signs of consolidation. In partial occlusion the respiration will be stridulous. The interpretation of these signs, taken in connection with other symptoms, must rest with the surgeon, but he must not be deceived by the lull in symptoms that not infrequently follows the initial blockade.

Tracheotomy.—The opening of the trachea is naturally the most frequent method for reaching an impacted foreign body, an operation that was advocated as early as 1644 by Frederic Manavius. Speedy relief is usually demanded, and ether or chloroform may be employed, or better, local anesthesia in order to retain the use of the extraordinary muscles of respiration. In doing this operation it is better to remove a considerable circle, excising one or two cartilaginous rings, since a simple slit may interfere with the expulsion of the body. If a slit only is made, lateral stitches holding it open are better than a tube. Not infrequently the foreign body is ejected by the primary cough induced by the operation; consequently it should be the duty of an assistant to watch carefully for its appearance. Fortunately, expulsion occurs in about one-half the cases operated upon. This result may be hastened by irritation with a feather. The opening should be as nearly as possible to the top of the sternum, and the forceps must be used with extreme

care. The difficulties in locating the body with tracheotomy forceps depend largely upon its character. A bean or kernel is of the same consistency and feeling as the cartilaginous bifurcation of the trachea. If the object is known to be a soft vegetable one, ordinary serrated forceps will not hold. Very short needle-like teeth which will sink into and hold the substance are better. With beads, buttons, tin whistles, etc., successful removal becomes difficult, even when they can be grasped.

One familiar with the use of the cystoscope may, by throwing the head far back and to one side, obtain a view of the foreign body through an inserted tube with electric light. For hard objects a large soft-rubber tube attached to a Bigelow litholapaxy evacuator may be carried down the trachea, and strong suction made upon it, or an aspirating pump or rubber ball may be attached. The evacuator is better, however, lest the body once extracted be again sucked back into position. In case of tacks, nails, etc., a small magnet or an electrical probe may be inserted through the trachea. Blunt curettes, wire hooks, scoops, loops, etc., are occasionally useful. The dangers to the trachea and bronchi by prolonged instrumentation are very great and should never be continued more than a few minutes. The risks of pneumonia are so greatly increased by instrumentation that Weist,² in an analysis of 1674 cases, found that the dangers of death from this cause in unsuccessful cases fully counterbalanced the benefits obtained by the number of extractions by tracheotomy. The proportions are one death in three and one-half cases without operation; one in four with tracheotomy. His conclusions in regard to this subject will probably not be materially changed by our present methods, since, although the pneumonia is septic in its origin, yet the sepsis even in former cases

2. Trans. Amer. Surg. Assoc., vol. 1, 1883, p. 121.

was probably not due in large measure simply to the instruments, but to the traumatism to the bronchi. Experiments show that the entering air is septic in the larger bronchi, but aseptic in the smaller divisions.

Failing to secure the intruding object through the tracheal opening, the surgeon is compelled to face two problems, either of which means serious risk to life. Shall he abandon the case to the expulsive efforts of Nature? Shall he rely upon the fact that many such offending bodies have been coughed out even after many years of suffering, and even when the diagnosis of tuberculosis of the lung has seemed positive? In determining the question the surgeon will consider both the character of the foreign body and the amount of interference that it is giving to the air supply. In the case of seeds, etc., voluntary expulsion with subsequent recovery occurs in nearly 74 per cent. of cases.

The other alternative is to reach the bronchus by a direct route. Should the surgeon decide to invade the chest wall in an heroic effort to reach the bronchi, he has before him a series of manipulations, perils, and difficulties that will put to the extreme test his skill, coolness and judgment. Before the introduction of the artificial respiration apparatus, the profound and deadly collapse that immediately followed any invasion of a healthy chest, was sufficient to deter most operators from undertaking such a course. Quenu lost twelve out of fifteen dogs, and while my own experiments have not been quite so serious, they have been very discouraging. In these animals and in rabbits and goats, the communication between the two pleural cavities which exists just above the tendinous center of the diaphragm renders the entrance of air doubly dangerous. Fortunately, we are now better equipped and can confidently rely upon our artificial respiration methods, but without such accessories the conditions are appalling. The

exceptional cases in which atelectasis does not occur are so few in number and are so unexplainable that they can not be depended upon. The surgeon must also consider the fact that even when the bronchus is reached by any route, the rigid walls prevent the easy recognition of the foreign body either by sight or touch. Again, as in Curtis' case, even when found in a secondary bronchus, it could not be reached or extracted. In experiments upon dogs I have repeatedly failed to find in the bronchi, pebbles that I had introduced through tracheotomy wounds.

Unfortunately, practice upon the cadaver yields but a slight realization of the conditions found in the living subject. I have at autopsy seen the bronchus of a dog apparently within easy reach, which same bronchus I had seen ten minutes before surrounded by huge pulmonary and azygos veins, with aorta, pneumogastric nerve, root of lung, and every structure in the neighborhood being violently dragged by the wide excursions of the lung in the frightful air hunger of the collapse from acute pneumothorax.

When an opening of any considerable size is made in the pleura and air rushes in, the sudden symptoms of collapse are usually instantaneous. The sudden shifting of the oxygenation of air upon one-half the ordinary circuit; the violent efforts of both inspiration and expiration; the enormous movement of the lung in the effort to produce a vacuum in the chest; the flapping of the pleura and mediastinum; the huge swelling veins filling and emptying and covering the area of operation; the great peril of the patient; the cyanosis and deficient oxygenation are such complications as will greatly delay and often entirely prevent all safe manipulative measures.

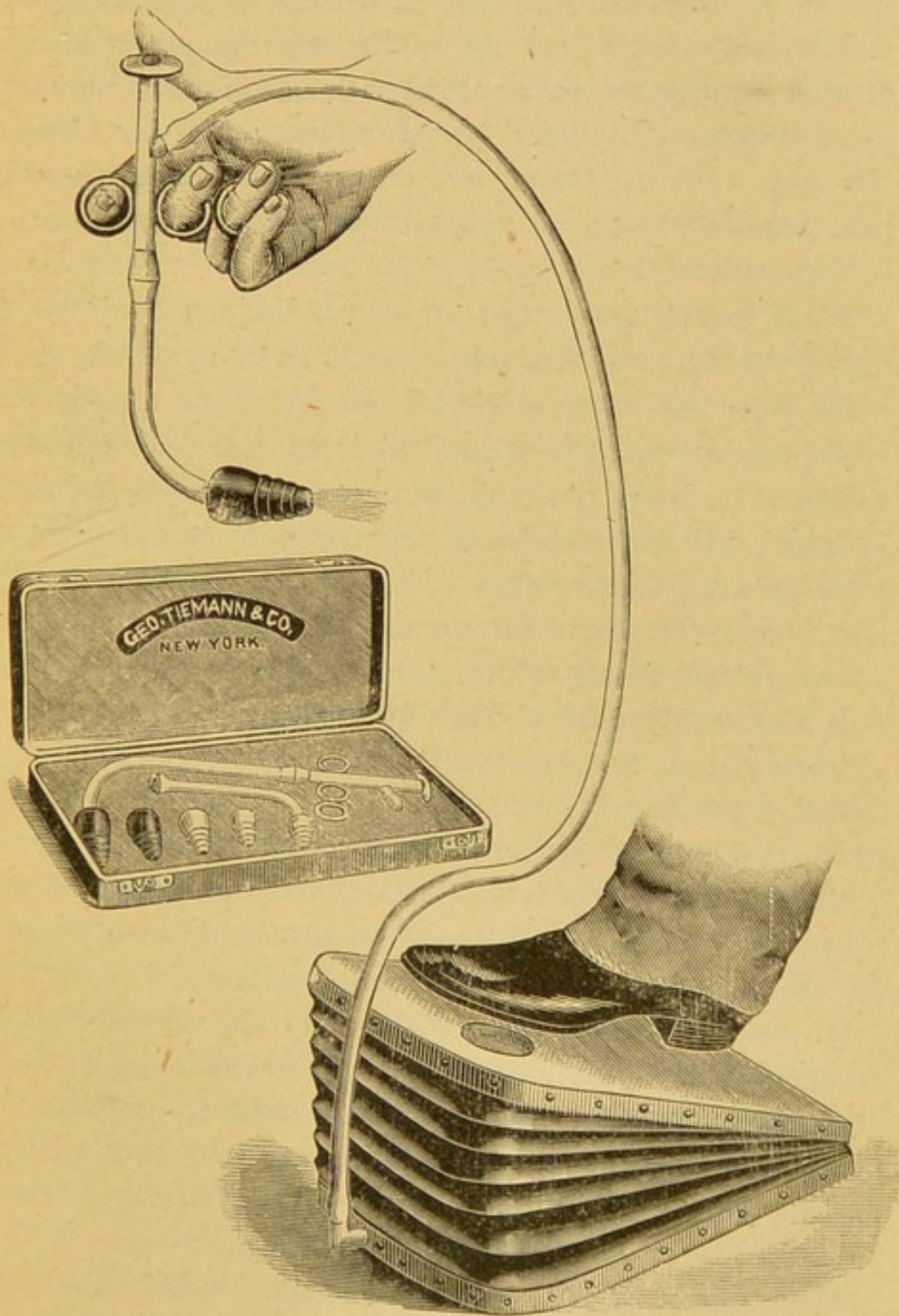
I have called attention to these difficulties, not to exaggerate them, nor to deter any surgeon from invading

the chest wall, but only to warn him against rash work without proper apparatus, since failure will necessarily bring discredit upon the surgeon and disaster to the individual. A somewhat extended but still incomplete examination of the literature on the subject fails to reveal a recovery after opening of the bronchus. My object is only to urge that unless an artificial respiration apparatus is at hand, and oxygen obtainable, it will be wiser to cease one's operative methods, after short manipulations through a large tracheal opening. With full appliances, however, and a full knowledge of the dangers, one may calmly proceed to enter the chest by a selected route. The conditions are entirely different from those encountered in a diseased lung or pleura, and preliminary injection of air or liquid will avail but little. A small dose of atropia will be helpful.

The oft-tried expedient of plugging the hole in the pleura, or of dragging the lung into the opening, or grasping the base of the lung, is here of no avail, since the search for the bronchus is absolutely prevented by any of these procedures. Air hunger being then the most serious of the complications, some reliable means of artificial respiration must be at hand, or the patient must die in a few moments. Fortunately, the Fell-O'Dwyer³ apparatus gives us the much-needed help. The apparatus consists of intubation tubes of various sizes attached to a handle, by means of which one of them of proper size can be held permanently within the chink of the glottis, while air is pumped directly into the lungs by bellows worked by hand or foot pressure. Insufflation is accomplished by moderate pressure about fifteen times in the minute, while expiration is accomplished by the resiliency of the chest walls.

Matas has improved upon this apparatus by using a double pneumatic pump, by means of which the exact

3. Northrop: N. Y. Pres. Hosp. Reports, 1896, p. 132.



amount of air introduced can be measured. He has also attached a manometer to regulate the degree of pressure, and has added a branch tube through which anesthetization can be kept up. The entering air is also filtered through a cylinder filled with cotton. The pump can also be employed for forcible aspiration of air from the lung. Bloom, Doyen and others have altered these instruments, but the principle of forcibly supplying air is the same.

After tracheotomy the intubation tip can be introduced through the opening so as to fit the trachea, or it can be carried into the glottis and the wound closed.

A pressure equal to 6 mm. mercury has been found sufficient to dilate the lung, while too great pressure, as 33 mm., will interfere with respiration. If too great force is used, emphysema or air vesicle rupture may take place. The artificial movements should correspond as closely as possible to the normal respirations.

By the employment of such an appliance for carrying on respiration, the chest wall may be opened either anteriorly, posteriorly, or at the side. A large opening while much more dangerous as regards atelectasis, yet greatly facilitates the operation. The employment of a tiny electric bulb within the chest also adds greatly to the rapidity and safety of the manipulations.

Anterior Thoracotomy.—Milton, of Cairo,⁴ has recommended an operation of entrance which he calls the normal thoracic invasion, and has successfully practiced it upon a living patient. In young children with flexible bones it would be feasible for reaching the bronchus.

With a saw he splits the sternum longitudinally throughout its entire length, and forcibly retracts the halves, thus separating the two pleural layers, and reaching the anterior mediastinum. In attempting

4. The Lancet, London, March 27, 1897.

this operation it should be remembered that the pleuræ come together not in the median line, but at a line nearly at the left border of the sternum. In this, as in all other routes of entrance to the thorax, it is absolutely essential that an efficient artificial respiration apparatus shall be constantly employed in the prevention of collapse.

Gaston's⁵ anterior opening is made as follows: A quadrilateral trap-door flap is made to include the third, fourth, fifth and sixth ribs, and turned back upon its base at the costal cartilages, thus avoiding the internal mammary. The outer end of the square flap is at the mid-axillary line, and the entire chest walls are cut through with knife and saw.

In making an anterior thoracotomy⁶ I have tried various forms of incision. The bronchus of the second lobe can be readily reached anteriorly, can be incised and afterwards stitched with a staphylorrhaphy needle. In another operation upon the right side, with excision of the fifth rib, I was easily able to expose the bronchus of the right upper lobe. The bronchial, pulmonary and a very high azygos vein were pushed aside and the bronchus incised for a third of an inch without wounding any other structure. Whenever the wound in the bronchus was not subsequently stitched, and the chest wall was closed at the end of the operation, each inspiratory act caused an increase of the pneumothorax by entrance of air through this slit, as was evidenced by the bulging of the wound and the increased dyspnea, ending in death.

The same thing occurred in another dog after an excision of the fifth rib, and an opening of the right bronchus. The pneumothorax steadily increased after

5. Trans. Amer. Surg. Assoc., vol. xiv, 1896, p. 465.

6. Trans. Amer. Surg. Assoc., 1891, p. 345, vol. ix. Trans. Coll. Phys., Phila., 1891. Amer. Jr. Med. Sciences, Dec., 1891. Univ. Med. Mag., Feb., 1892.

the closure of the wound, with bulging and escape of air from within outward at each respiration until death occurred. It is easily seen that while air can pass from the interior of the bronchus outwardly, the rounded shape of the tube prevents return from pleural cavity to bronchus. This air from the large bronchi is septic.

Posterior Thoracotomy.—Nesiloff, Bryant and others have proposed to reach the root of the lung posteriorly. Bryant's operation is as follows:⁷ In order to give room for the flap, the scapula is carried far outward by raising the arm and carrying the shoulder forward. A square flap three inches in size is made, with its base toward the spinal column, and three ribs, the third, fourth and fifth, are sawed through as far out as their angles, near the posterior border of the axilla. The pleura is then separated from the anterior surface of the ribs by the fingers, and the flap is turned backward upon its base as a hinge, the ribs being separately turned out. The intercostal arteries were ligated before opening the pleura. The presence of the vena azygos and the pulmonary vein will greatly interfere with manipulations, and these, as well as the pneumogastric, must be carefully avoided. If the foreign body can be located, a long incision (long enough to permit removal without laceration) is made in the bronchus. The bronchus is not closed, but packed and drained, as there will be discharge of mucus and inflammatory products. The flap with the ribs should be replaced, but the middle rib may be removed entirely for drainage, if advisable. Any given spinous process indicates the situation of the vertebral extremity of the rib immediately below. Bryant places the division line between the posterior mediastinum proper and the posterior part of the superior

7. Bryant: Posterior Mediastinum. Trans. Amer. Surg. Assoc., vol. xiii, p. 443

mediastinum at the lower portion of the fourth dorsal vertebra. The separation of the pleura is accomplished with the finger, and also by a sawing motion of a strong silk thread carried beneath the rib. The same ligature may be used to draw beneath the rib a chain saw, so as to operate from within outward and avoid premature wounding of the pleura. This opening is probably more favorable for reaching the esophagus than the bronchus. The bronchus in a man will be distant about one and one-half inches from the opening. The operation is one requiring careful manipulation, cool judgment, speedy recognition and skilful treatment of each danger as quickly as it arises.

Curtis,⁸ in a posterior thoracotomy for an impacted seed vessel of a plant in the right bronchus, tried to extract it with a forceps through the trachea, but failed. At a second operation the boy was placed face downward, with one shoulder raised. A quadrangular flap was raised from the posterior portion of the chest and turned outwardly toward the scapula. Its free edge was near the vertebral spine. The fourth, fifth and sixth ribs were then stripped. The lower layer of the periosteum and intercostal muscles were divided without opening the pleura. The ribs being lifted up, the pleura was carefully detached from the posterior mediastinum and from the posterior chest wall. The bronchus was easily reached, but the azygos vein covering it prevented incision. He encountered the same difficulties that I have always experienced, the violent action of the lung and of the flapping pleura, which interfered most seriously with all manipulations, and he was finally obliged to pack the wound and suspend his efforts. The next day he renewed the attack. The pleura had now become adherent to the lung, and the action was less violent. The bronchus was opened through its posterior

8. Curtis: *Annals of Surgery*, 1898, vol. xxviii, p. 605.

wall without hemorrhage, but search with forceps failed to find the body; neither could it be found in the trachea. It was finally discovered by the fingers through the lung substance. The pleura was sewed to the lung and the lung held by a silk stitch. The thermocautery was used directly through the lung substance, but failed to reach the object. The operation was finally suspended on account of the patient's collapse. A drainage tube was inserted with packing, but pneumonia developed on the following day and the patient died in forty-eight hours. At the autopsy the foreign body was found in the secondary bronchus near the end of the drainage tube. The object had been swallowed three days before the first operation. Rushmore⁹ in a similar attempt anteriorly was compelled to abandon the operation, and the patient died.

Anyone interested in the subject of intralaryngeal insufflation will be abundantly repaid by perusing Matas' able articles.¹⁰ In these papers he shows that insufflation through a deliberately introduced laryngeal tube was in common practice for the resuscitation of the drowned as far back as the War of the Revolution; that William Hunter used both bellows and intralaryngeal tubes; that Matas' present pump was forestalled by the double pump of Courtois attached to a tracheotomy canula, more than a century ago; that in the earliest years of the last century such a tube was a part of the regular obstetrical outfit for the resuscitation of new-born infants;¹¹ that Ribemont in 1877 used an intubation canula almost precisely like the one of O'Dwyer; that Truehead of Texas again in 1869 brought out an instrument upon the same plan as the Fell-O'Dwyer instrument.

9. Rushmore: N. Y. Med. Jour., 1891, liv, 85.

10. Trans. Louisiana State Med. Soc., 1898. Trans. South. Surg. and Gynaec. Assoc., Nov., 1899. Annals of Surgery, 1899, p. 409.

11. Depaul: Jour. de Chirurgie, 1845.

The Bloom modification of attaching an ordinary rubber syringe bulb to the laryngeal tube is excellent, and the Doyen¹² double bellows and tubes are also good.

The work of Tuffier¹³ and Hallion, Quenu and Longuet, Matas, Parham and others, has added greatly to the practical application of artificial forcible insufflation through an intralaryngeal tube. It is now the best known assistant, not only in the performance of lung surgery, but also in the resuscitation of the asphyxiated, the drowned and the new-born. It is also most serviceable in opium poisoning, and in the arrested respiration of anesthetization. (I always keep the Fell-O'Dwyer apparatus alongside the oxygen jar, close outside my clinic door.)

When the foreign body remains permanently fixed in the bronchus, septic pneumonia is a frequent result. In many cases this process leads on to septic abscess, or, if the blockade is complete, gangrene may result. Expulsion of the foreign body and of the purulent surrounding material sometimes occurs, often after months of delay. More frequently, however, death ensues. In the chronic cases the hemorrhage, emaciation and septic conditions often simulate tuberculosis. The proper treatment for all such abscesses or gangrenous areas of lung is a surgical one. The diseased area having been carefully located, a rib should be excised subperiosteally, and contamination of the pleural cavity prevented by suturing of the lung to the chest wall in the form of a parallelogram, before opening. A sharply curved perineal needle with handle is convenient for this purpose. Incision of the abscess and free drainage will offer the best hope for cure.

12. Doyen: *Technique Chirurgicale*, pp. 129-133. *Revue de Therapeut. Med.-Chirurg.*, Jan. 15, '98, vol. xlv.

13. Tuffier: *Société de Biologie*, Nov. 21, 1896. *Bull. et Mem. Soc. Chirurgie*, Feb., 1897.

CONCLUSIONS.

1. Coughing should be encouraged; forcible inspiration restrained.

2. Inversion in the prone position as a domestic practice is advisable.

3. Laryngoscopy is helpful if the body is lodged at the vocal cords. It may be extracted by forceps or by laryngotomy.

4. If time permits, the *x*-ray may be brought into serviceable use for diagnosis.

5. Careful diagnostic investigation is important to determine the actual presence of an impacted body, and its location.

6. Tracheotomy under local anesthesia should be the rule if the object is lodged at the bifurcation or in the bronchi. Tracheoscopy, suction and forceps' manipulation must be cautiously employed. Prolonged instrumentation adds greatly to the danger of pneumonia.

7. If extraction is not secured through the tracheotomy wound the chest wall should not be invaded unless an artificial respiratory apparatus like the Fell-O'Dwyer is at hand, and oxygen available. With the assistance of these appliances, however, the bronchus may be reached, anteriorly or posteriorly, since, by their use, rhythmical movements can be maintained.

8. Resultant abscess of the lung should be treated by incision and drainage.