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Da Costa

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Modern Surgery - Chapter 25. Surgery of the Respiratory Organs

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XXV. SURGERY OF THE RESPIRATORY ORGANS.

I. DISEASES AND INJURIES OF THE NOSE AND ANTRUM.

Foreign bodies in the nose are usually introduced through the anterior nares, but in rare instances they enter by way of the posterior nares. Small particles are often expelled spontaneously; larger pieces collect mucus and epithelium and become fixed. Some materials swell after lodgment.

Treatment.—In many cases anesthesia is required. Illuminate the nostril, and, if the foreign body can be seen, insert a hook back of it and effect its removal by means of forceps. Some foreign bodies require to be pushed back into the nasopharynx. Occasionally expulsion may be effected by inserting a rubber tube into the unblocked nostril and telling the patient to blow forcibly through the tube. In serious cases a specialist should be summoned to remove a portion of the turbinated bone or to perform whatever operation he thinks best.

Inflammation and Abscess of the Antrum of Highmore (of the Maxillary Antrum).—The source of this disease may be inflammation of the nose or periostitis around the roots of the teeth. In some cases the natural opening into the meatus is patent; in other cases it is partly or completely blocked. Caries and necrosis may arise. The **symptoms** are pain, edematous swelling of the face, and thinning of the bone so that it may crepitate under pressure. When pus has formed, if the antral opening is patent, certain positions of the head will cause a purulent flow from the nose, and if a speculum is inserted pus may be seen as it flows into the nose. The opening of the maxillary antrum into the nasal channel is at the summit of the antrum; hence the antrum drains when the head is inverted. The ethmoidal cells and frontal sinus drain best when the patient is upright. Wipe the interior of the nose and place the patient with his head between his knees. If the nostril fills with pus, it comes from the antrum (Cobb). In severe cases the jaw expands, the eye protrudes, and great tenderness of the alveolus exists. Percussion exhibits a dull note. In making a diagnosis it is well to take the patient into a dark room, insert an electric light into the mouth and note the diminution of light-transmission on the diseased side as contrasted with the sound side. Transillumination may be easily practised by the use of a cautery electrode, protected by a small glass vial. Any cautery battery may be employed (plan suggested by Ohls). Exploratory puncture will settle a doubtful diagnosis. This may be by way of the lower meatus, the canine fossa, or the alveolar process.*

Treatment.—Before pus forms order the use of hot fomentations and remove any diseased teeth. When pus has formed, evacuate it at once. Before performing a severe operation try the effect of opening into the antrum from the nose, by means of Krause's trocar, followed by insufflation of iodoform. If this procedure fails, other means may be employed. If the disease arises from a carious tooth, pull the tooth and push a trocar through its socket into the antrum. If the teeth are sound,

* Cobb, in Boston Med. and Surg. Jour., May 7, 1896.

bore a hole with a large gimlet or with a bone-drill above the root of the second bicuspid tooth and one inch above the edge of the gum. A counter-opening should be made into the inferior nasal meatus. A drainage-tube is pulled from the first opening into the nose and is allowed to protrude from the nostril. Irrigate daily with normal salt solution. In three or four days discontinue through-and-through drainage, but prevent the first opening closing until the discharge ceases to be purulent. In severe cases make a free incision through the canine fossa by means of a chisel.

Distention and Abscess of the Frontal Sinus.—The usual cause is an injury which may long antedate the symptoms. This injury causes or leads to blocking of the infundibulum; secretion accumulates and distends the sinus; and in some cases pus forms. In many cases the fluid slowly accumulates, and it requires years to produce marked symptoms. In other cases infection takes place, and the symptoms are positive and violent. If the outlet into the nose is not permanently blocked, the fluid may discharge itself from time to time. In the chronic cases there is rarely much pain. The chief sign is a swelling of the inner or upper part of the orbit, which swelling progressively increases and finally displaces the eye. If at any time acute symptoms supervene, there will be pulsatile pain, discoloration, and tenderness.

Treatment.—In some cases it is possible to pass a trocar upward from the nose into the sinus, and so drain and irrigate. In most cases an incision should be made through the soft parts, and the sinus opened by a trephine or chisel. After the sinus has been opened it must be curetted. The opening into the meatus should be restored and enlarged, and a drainage-tube must be passed from the forehead incision into the nostril. I usually prefer to open the sinus by making an osteoplastic flap in the anterior wall.

2. DISEASES AND INJURIES OF THE LARYNX AND TRACHEA.

Edema of the Larynx (Edema of the Glottis).—The **causes** of edema of the larynx are: acute laryngitis; chronic diseases, such as tuberculosis, malignant disease, or syphilis; inflammatory disorders, such as diphtheria and erysipelas; acute infectious diseases; Bright's disease; aneurysm; whooping-cough; pneumonia; quinsy; wounds of the larynx; wounds of the neck; scalds and burns of the larynx, and the inhalation of irritating vapors, such as those of ammonia and sulphur. The **symptoms** are sudden and rapidly increasing dyspnea, respiratory stridor, huskiness of the voice, and finally aphonia. The swollen epiglottis may be felt with the finger and may be seen with the help of a mirror.

Treatment.—In cases in which edema of the larynx is not excessively acute, introduce a gag between the teeth, hold the mouth open, take a knife wrapped to within one-quarter of an inch of its point, make multiple punctures into the epiglottis, and favor bleeding by the inhalation of steam. In severe cases perform intubation or tracheotomy.

Wounds and Injuries of the Larynx.—The larynx may be injured internally by foreign bodies, and externally by blows and cuts. A condition often met with is *cut throat*, the result usually of a suicidal attempt on the part of the patient or a homicidal effort on the part of an assailant. The cut of the suicide is usually in front; as a rule, it misses the great vessels, but divides the

cricothyroid or thyrohyoid membrane. The epiglottis may be incised, or even be cut off. If a large vessel is cut, death rapidly occurs. The immediate dangers of cut throat are hemorrhage, suffocation by blood in the windpipe and bronchi, or by displacement of parts, and entrance of air into veins. The secondary dangers are pneumonia, infection and sepsis, exhaustion, and secondary hemorrhage. The remote dangers are stricture and fistula (Keetley).

Treatment.—In wounds of the throat arrest hemorrhage, remove clots from the larynx and trachea, bring about reaction, asepticize the parts as well as possible, suture the deeper structures with silver wire, catgut, or kangaroo-tendon, and the superficial parts with silkworm-gut, dress antiseptically, and place a bandage around the head and chest so as to pull the chin toward the sternum. If laryngeal breathing is much interfered with, perform tracheotomy. Feed the patient through a tube until union is well advanced. The old method of leaving the wound open is to be condemned. When sutures are used, primary union may be obtained. This fact was proved by Henry Morris.

Scalds of the Glottis.—(See section on Burns and Scalds.)

Foreign Bodies in the Air-passages.—The lodgment of foreign bodies in the air-passages is a frequent accident. Small solid bodies are usually expelled by coughing. Liquids and solids rarely pass beyond the larynx (except in laryngeal disease or palsy, wounds of the floor of the mouth, cut throat, and in people unconscious or very drunk). In vomiting during or after the administration of an anesthetic, or in the vomiting of drunkards, the vomited matter may find its way into the larynx or lungs. There is great danger of this accident in an operation upon a patient with intestinal obstruction who has stercoraceous vomiting. In most instances of foreign bodies lodged in the air-passages it will be found that the object was being held in the mouth when a sudden deep inspiration was taken (often during laughter). The **symptoms** are *immediate*, due to obstruction by the body and to spasm, and *secondary*, due to the situation of the body and the changes it undergoes or induces.

Lodgment in the pharynx causes violent dyspnea. The body can be seen or felt.

Lodgment in the Larynx.—In a severe case the patient fights madly for air; his face becomes livid and cyanotic; his veins stand out prominently; speech is impossible, though he may make noises and utter harsh cries; violent coughing begins, and then vomiting; he tries to force a finger down his throat and clutches at his neck; sweat pours from him; he feels a sense of impending dissolution, and he falls unconscious, with incontinence of feces and urine.* In a less severe case violent dyspnea gradually departs and the patient lies exhausted; but dyspnea and cough are liable to recur suddenly at any time because of spasm, and they may be induced by a change of position. These attacks of fierce spasmodic cough are not at first linked with expectoration, but after inflammation begins there is a profuse and often bloody expectoration. Inflammation follows more rapidly the lodgment of a sharp or irregular body than it does that of a round or smooth body. Inflammation is apt to produce edema of the glottis, bronchopneumonia, or ulceration and necrosis of the larynx. Any sort of foreign body in the larynx may at any moment produce

* See Moullin's graphic description in his "Treatise on Surgery."

spasmodic dyspnea, and is always very liable to cause edema of the glottis. The body if bony or metallic can be detected by the *x*-rays.

Lodgment in the Trachea.—The immediate symptoms of a foreign body in the trachea depend on the shape and weight of the body, and whether it becomes fixed in the mucous membrane or moves to and fro with the air-current. A smooth, heavy body falls to the tracheal bifurcation, and, if it does not enter a bronchus, moves with every breath, and by its movement causes violent laryngeal spasm, cough, and whooping inspiration without aphonia. The patient is often conscious of the movements of the foreign body, and the surgeon may detect them with the stethoscope. The foreign body may be found with the Röntgen rays. A foreign body in the trachea is liable to cause death by dyspnea, or it may ascend so as to be caught in the larynx, or may even be expelled. Irregular or sharp bodies lodge in the mucous membrane, produce inflammation, frequent cough, and expectoration, and finally lead to ulceration. Bodies which swell from heat and moisture tend to lodge and to become fixed (seeds may sprout).

Lodgment in a Bronchus.—Foreign bodies in the bronchi seriously endanger life. They usually lodge in the right bronchus. When a small lung-area is obstructed the obstructed side shows diminished respiratory movement and murmur with occasional whistling sounds and large moist râles; the percussion-note is normal. When an entire lobe is obstructed all respiratory sounds are absent over it, and over the unobstructed lung respiration is exaggerated; the percussion-note over the obstructed area is at first resonant, but becomes dull. The *x*-rays will enable the surgeon to detect some foreign bodies in a bronchus. Lodgment in a bronchus may cause bronchopneumonia, abscess, hemorrhage, and even gangrene. In some cases the body has been expelled spontaneously. In rare instances people have lived for years with lodged foreign bodies. If death does not soon follow the lodgment of a foreign body, an abscess is very apt to form.

Treatment.—If a foreign body lodges in the pharynx, try to pull it forward; if this fails, push it back into the esophagus. In lodgment in the larynx or below, if the symptoms are very urgent, at once perform a quick laryngotomy. If the symptoms are not so urgent, get a complete history of the accident and find out the nature of the foreign body. Be sure a foreign body is retained in the respiratory tract, and determine what its situation may be. Often a laryngologist can remove a foreign body from the larynx by means of forceps, a mirror and lamp being used for illumination. The fauces and upper portion of the larynx should have cocaine applied to them to lessen pain and spasm. If the surgeon fails in extraction by forceps, and laryngotomy has been performed, continue the search through the opening in the cricothyroid membrane; if laryngotomy has not been performed, let the larynx be opened by *thyrotomy* (a vertical incision between the alæ of the thyroid cartilage, and the separation of these alæ to permit of exploration). After a thyrotomy suture the perichondrium with catgut. If the foreign body is in the trachea, perform ordinary tracheotomy; if it is in a bronchus, perform low tracheotomy. Tracheotomy prevents suffocation from laryngeal spasm or edema of the glottis. It may be possible to remove the body in the bronchus through the incision of a low tracheotomy, and this ought to be tried. The foreign body may be expelled through the tracheotomy wound; if it is not expelled, search

the trachea and bronchi with Gross's forceps, with probes, with hooks, or with the finger. If the foreign body cannot be found, put the patient to bed, and maintain a moist atmosphere in the room. As a rule, when the foreign body is not found insert a tube. If the foreign body be extracted, do not insert a tube (unless edema of the glottis exists or is likely to come on), do not suture the wound, but cover it with moist gauze and let it heal by granulation. Morphine and sedative cough-mixtures are given. Gross says that even when a foreign body has long been retained an operation should be performed if the air-passages are not seriously diseased. What shall be done when a foreign body is lodged in a bronchus and we are unable to extract it through a tracheotomy-wound? Truc said if "the patient is in danger of death" go through the chest-wall and attempt to remove the body. He said this with a full knowledge of the difficulty of locating the body. This difficulty has been partly overcome by the x -rays, and it seems now more certainly our duty to operate than it was a short time ago. Nasiloff proposed to reach the obstruction by the posterior route after rib resection. Curtis attempted this, and though the patient died, his operation proves that the method is feasible. An operation by the posterior route should be performed at once, if low tracheotomy fails.

3. OPERATIONS ON THE LARYNX AND TRACHEA.

Tracheotomy.—The instruments required in this operation are scalpels, dissecting forceps, a dry dissector, hemostatic forceps, scissors, a tenaculum, aneurysm-needle, tubes, tapes, Paquelin cautery, needles, needle-holder, a mouth-gag, tongue-forceps, foreign-body forceps, retractors, and, if membrane is present, feathers and a solution of bicarbonate of sodium. In a formal operation give chloroform, but in an emergency case this cannot be done. The patient may be placed supine with a sand-pillow under the neck and with the head thrown over the end of the table. If a child, Liston used to wrap it up to the neck in a sheet to prevent movements of the limbs, would seat himself on a chair, place the child upon the nurse's lap, and takes its head between his knees. The head must be exactly in the middle line, and extended (in an adult this gives two and three-quarters inches of trachea above the manubrium; in a child of ten, two and a quarter inches; in a child of six, about two inches). The operator stands to the right side when the patient is supine. If bleeding is profuse when the surgeon is ready to open the trachea, place the patient in the Trendelenburg position with the neck extended. The trachea may be opened above or below the isthmus of the thyroid gland. The isthmus in an adult usually lies over the second and third rings (Fig. 345). The isthmus in a child usually lies over the first ring or even over the space between the cricoid cartilage and the first ring. The high operation is always

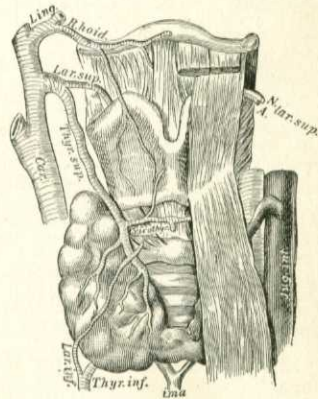


Fig. 344.—Blood-supply of the larynx and trachea (Esmarch and Kowalzig).

chosen except in cases where it is desired to search for a foreign body in a bronchus.

High Tracheotomy.—High tracheotomy is preferred because in this region the muscles are distinctly separated (Fig. 345), the main vessels of the neck and the inferior thyroid vessels are not encountered, the anterior jugular veins are small and have very few transverse branches, and the trachea is near the surface (Treves). The surgeon accurately locates the cricoid and thyroid cartilages. An incision is begun at the upper border of the cricoid cartilage, and is carried down precisely in the middle line for about one and a half inches. Treves advises the operator to steady the skin of the neck with the fingers of the left hand and to cut with the unsupported right hand (if the hand be supported, the respirations will interfere with the operation). The skin, the superficial fascia, and the anterior layer of the cervical fascia are incised, the sternohyoid and sternothyroid muscles are separated, and the fascia over the trachea is divided. This fascia is attached above to the cricoid cartilage, and it divides below into two layers to invest the thyroid body and its isthmus. If veins are in the line of the incision, they are pushed aside, but it is not necessary to take the time to apply double ligatures. Even if bleeding is profuse, as soon as the trachea is opened and air enters freely into the lungs, venous congestion is relieved and bleeding is apt to cease. If hemorrhage be violent and the veins are not at once caught by forceps, it may be well to place the patient in the Trendelenburg position before incising the windpipe, in order to prevent the entrance of blood into the lungs. Before opening the trachea the isthmus of the thyroid gland is pushed downward; if it cannot be pushed down sufficiently, a transverse incision is made through the fascia at the upper border of the cricoid cartilage, and the fascia, and the isthmus with it, is lifted off the trachea (Bose's method). A tenaculum is inserted into the cricoid cartilage in order to steady the tube. The back of the knife is turned toward the sternum, a finger being held upon the blade to prevent too deep a cut being made. The

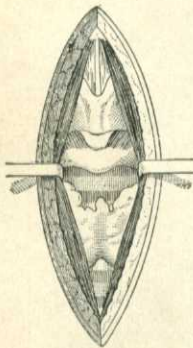


Fig. 345.—Parts exposed in tracheotomy (Es-march and Kowalzig).

knife is plunged, as if it were a trocar, into the mid-line of the trachea above the isthmus, and two or three rings are divided from below upward. The hook is not removed until the operation is completed. If a foreign body is present, an attempt is made to remove it; if success attends the effort, no tube need be worn; but if the body is not found, a tube must be used. In croup or diphtheria remove membrane (by means of a feather and a solution composed of bicarbonate of sodium $\bar{3}$ ij, glycerin $\bar{3}$ j, water $\bar{3}$ x—Parker) and insert a tube. The edge of the cut is grasped with the dissecting forceps, the mucous membrane being included in the bite; the head is placed erect, the tube is introduced, and the tenaculum is removed. Secure the tube by tapes, and suture the wound below the tube. Remove the tube at the first moment consistent with safety. In croup or diphtheria put a screen around the bed; have the air kept moist by steam; remove the inner tube and clean it every two or three hours at first; clean the outer tube whenever required. Clean the larynx and trachea from time to time by means of a feather and Parker's solution. A steam spray atomizer may be used with advantage.

Quick laryngotomy must never be attempted upon a child under thirteen years of age, because of the small size of the cricothyroid space before this age (Treves). In view of the difficulty of introducing a tube and of wearing it so near the vocal cords, laryngotomy should not be performed for croup, diphtheria, or for any condition in which a tube must be long worn. The operation is performed as follows: Make an incision an inch and a quarter long in the middle line, from above the lower edge of the thyroid to below the lower border of the cricoid cartilage. Divide the skin, superficial fascia, and deep fascia, separate the cricothyroid and sternothyroid muscles, divide the deep layer of fascia, and cut the cricothyroid membrane horizontally just above the cricoid cartilage. The tube must be shorter than the ordinary tracheotomy-tube. An operation which opens vertically the cricothyroid membrane, the cricoid cartilage, and the upper rings of the trachea is called "laryngotracheotomy."

Intubation of the Larynx (O'Dwyer's Operation).—Bouchot conceived the idea of intubation; O'Dwyer perfected it and made it a genuine scientific proceeding. The instruments required for the performance of this operation are a mouth-gag, an instrument to hold the tube and introduce it, and an instrument for extracting the tube. The collar of the tube has a perforation through which a piece of silk is fastened to draw out the tube. The child is wrapped in a sheet to secure the limbs, is seated in a nurse's lap, and its head is held by an assistant. The jaws are opened and held apart by the self-retaining mouth-gag. The surgeon sits in front of the patient, wraps a piece of rubber plaster about the index-finger of his left hand, and passes the finger into the child's mouth until its tip touches the epiglottis. He introduces the holder and tube (observing if the silk is free) along the surface of the tongue until the obturator touches the epiglottis; raises the epiglottis with the left index-finger, and passes the tube into the larynx; places the left index-finger against the tube, and withdraws the holder with the right hand. The silken thread is tied to the ear, and the nurse is directed to employ the thread to remove the obturator if it becomes obstructed or is coughed up. The tube is removed in two or three days; if breathing is easy, it is not reintroduced; but if dyspnea recurs, it is replaced for two or three days more. If, in introducing the tube, a mass of false membrane is pushed before it into the trachea, breathing ceases, and, if the mass is not at once coughed up, tracheotomy must be performed. Feed these patients on semisolids rather than upon liquids (mush, soft eggs, and corn-starch); and if trouble occurs in swallowing these articles, feed by the rectum or by means of a nasal or an oral tube. In opium-poisoning, in asphyxia, in acute traumatic pneumothorax, and in cerebral injuries, intubation may be associated with the use of Fell's apparatus (page 666).

4. DISEASES AND INJURIES OF THE CHEST, PLEURA, AND LUNGS.

Pleuritic effusion may arise from the lodgment of foreign bodies, from injury by fragments of a broken rib, from tumors, and from inflammation of the lung, but most usually is due to pleuritis. The commonest cause of primary pleuritis is tuberculosis. Inflammatory effusion is nearly always unilateral (except in tuberculous pleuritis, but even this form is often one-sided in origin).

The **signs** of pleuritic effusion are: dulness on percussion over the area of effusion, this dulness, when the patient is erect, being at the lower part of the chest and ascending higher posteriorly than anteriorly (alteration of position alters the situation of the dulness); the intercostal spaces are widened, the intercostal depressions are obliterated, the intercostal muscles are rigid and their rigidity lessens the mobility of the ribs (Przewalski). No breath-sounds can be detected in the area of percussion flatness when the collection of fluid is large, but in small effusions deeply situated the breath-sounds are often audible; the percussion-note above the liquid is hyperresonant or tympanitic, and is often associated, at the edge of the liquid, with a friction-sound; posteriorly, high up and near the spine, there are bronchial respiration and bronchophony. In cases of pleurisy with effusion pain almost or quite disappears with the advent of effusion, dyspnea comes on, and the patient lies upon the diseased side. Cough always exists if there is pleuritic effusion, and fever is usually present. In serous effusions the diagnosis may be confirmed by the aseptic introduction of a clean aspirating-needle.

The **treatment** in this stage is to discontinue arterial sedatives and to stimulate if the circulation calls for it. The exudation is removed by the administration of salines, compound jalap powder, or elaterium. If these means fail, if the effusion is excessive, or if it is producing dyspnea, at once aspirate. Aspiration should be performed for an effusion which fills the whole chest, which produces great dyspnea, or which has lasted for three weeks. In tuberculous pleuritis early aspiration is not advisable, but aspiration should be performed if the fluid becomes purulent, if the effusion displaces the heart considerably, and if it adds notably to the dyspnea. If an effusion becomes purulent, the proper procedure is incision, resection of a portion of a rib, and drainage.

Empyema is a collection of pus in the pleural cavity. It may begin suddenly, but rarely does so. Among the causes of empyema are those of serous effusion. Empyema is due to infection of the pleura, and in every case a bacteriological study should be made of the pus to discover the causative bacterium. The pneumococcus is the causative micro-organism in many of the cases which follow pneumonia. These bacteria live but a short time, and in empyema due to pneumococci these micro-organisms may not be discoverable when the pus is evacuated. In most cases of empyema streptococci or staphylococci can be found in the pus. These micro-organisms may appear in an empyema induced originally by pneumococci (Stephen Paget). In empyema developing during or after typhoid fever the typhoid bacillus may be discovered. In putrid empyema various bacteria are found. Bouchard thinks acute empyema has a special organism. The bacilli of tuberculosis are present in tuberculous empyema, but may disappear after mixed infection with pyogenic bacteria. Empyema may be due to a wound or contusion, an attack of pneumonia, tuberculous pleuritis, phthisis, influenza, pyogenic infection of a serous effusion, caries of a rib, specific fevers, especially typhoid, peritonitis, abscess of the liver, suppurating hydatid cyst of the liver, subphrenic abscess, malignant disease of the pleura, gangrene of the lung, and pneumothorax.

Acute Empyema.—The *signs* are in reality those of pleuritis with effusion—viz., dulness on percussion, absent breath-sounds over the purulent matter, bulging of the intercostal spaces, and sometimes edema of the

skin of the chest. The *symptoms* of acute empyema are dyspnea, pallor, cough, sweats, chills, and usually irregular fever, but fever may be absent. There is marked leukocytosis. The fingers may become clubbed. An empyema of the left side may pulsate. A neglected empyema may break into the lung, esophagus, or pericardium, through an intercostal space, or may point in the lumbar region. When an empyema is pointing externally, the condition is called *empyema necessitatus*. A total empyema is a condition involving the entire pleural sac. In a partial or localized empyema the purulent matter is encapsuled. After an empyema ruptures spontaneously it rarely heals without surgical interference, a pleural fistula, as a rule, persisting. A subphrenic abscess may follow an empyema. When an empyema ruptures into a bronchus, pneumothorax arises as a rule. Empyema may cause death by compression of the heart and lung, pulmonary embolism, pericarditis, peritonitis, cerebral embolism, cerebral abscess, septicemia, exhaustion, or rupture into a bronchus.

A small empyema due to pneumococci occasionally, though very rarely, undergoes spontaneous cure, the pus being absorbed (Stephen Paget).

A small empyema is occasionally cured by encapsulation with fibrous tissue.

Under exceptional circumstances, even a large empyema may be cured by breaking externally or into a bronchus.

Empyema is so rarely cured spontaneously that it does not do to trust to Nature, and practically almost every case will die without surgical treatment.

Double empyema is a rare and extremely fatal condition. There are two forms of empyema, the acute, which comes on as a violent inflammation, and the chronic.

Chronic empyema may follow an acute empyema, or the condition may be chronic from the beginning. In chronic empyema the lung is compressed, shrunken, and strongly adherent, and the pleura is very thick. In some cases the pleura is over an inch thick. This thickening is brought about by the deposition of layer after layer of fibrin. In not a few cases a chronic empyema succeeds an acute one or is itself maintained because a drainage-tube has slipped into the pleural cavity and remains lodged.

A *closed empyema* is one in which no opening has been made by the surgeon and no opening has formed spontaneously. In a closed empyema the pus is rarely putrid; in an *open empyema* the pus is often putrid.

Treatment of Empyema.—The treatment is purely surgical, and the earlier it is applied the better. To delay allows the pleura to thicken and permits adhesions to form, conditions which prevent lung expansion and retard or even prevent cure. The results of operation are better in children than in adults; in small collections than in large; in recent than in advanced cases; in pneumococcus empyema than in empyema due to other organisms. The surgical methods comprise aspiration, incision, rib-resection, the operation of Schede, the operation of Estlander, and the operation of Fowler (see pages 675 and 676).

In acute empyema general practitioners are very apt to aspirate, and yet aspiration is almost never curative. It may cure a pneumococcus empyema in a child, and an encysted empyema, but even in these it will usually fail. Aspiration is not to be considered a method of curative treatment. It is to be regarded as the surgical treatment only in a tuberculous empyema in a young person with rapidly progressing phthisis, because in such a case incision will

probably prove fatal (Lockwood). It is a very useful diagnostic expedient, and enables the surgeon to prove the existence of pus, and the pus which is obtained can be examined bacteriologically. In a very large effusion it is wise to aspirate and withdraw part of the effusion a day or two before operating. This enables the patient to take an anesthetic with greater safety and obviates the danger attending the rapid evacuation of a large amount of pus.

In a recent empyema incision and drainage or rib resection and drainage will often cure the case, and yet many of the results are unsatisfactory. In some cases the discharge ceases and yet pulmonary function is not completely restored. In other cases a pleural fistula persists. If a profuse discharge is maintained, amyloid disease may arise. An acute empyema is to be drained by intercostal incision or by resection of a rib (page 674). A chronic closed empyema is drained in the same manner, and if the lung will not fully expand and remains stationary for a month Schede's or Estlander's operation is required. An open chronic empyema, in which the lung will not expand, requires the operation of Schede, Estlander, or Fowler (pages 675 and 676). When there is an external opening which persists, and which joins a long, narrow cavity, the condition is spoken of as *pleural fistula*, and pleural fistula is often produced by the prolonged use of a drainage-tube and sometimes by caries of a rib. A pleural fistula may sometimes be cured by dilatation of the sinus, but in most cases it is necessary to resect one or more ribs. Even if there is no opening on the cutaneous surface, there may be one into a bronchus.

Non-traumatic Pneumothorax.—By the term pneumothorax is meant the presence of air in the pleural cavity. As a rule, besides air there is serous fluid or pus. It may be due to the rupture of an empyema into a bronchus; to the rupture of a tuberculous area, an area of gangrene, an abscess of the lung, an air-cell in a state of emphysema, or of pulmonary tissue softened because of hemorrhagic infarction. The immediate effect of the entrance of air into the pleural sac is to compress the lung, the degree of compression being in proportion to the amount of gas present. In severe cases the lung is squeezed against the vertebral column, and the heart, the diaphragm, and even the liver are displaced. In some cases, where the admission of air does not continue, the amount set free in the pleural sac is absorbed. In most cases pyopneumothorax (empyema) follows.

Symptoms.—The symptoms usually arise suddenly, and consist of distressing dyspnea, pain in the chest, lividity, and rapidity and weakness of the pulse. In some cases of phthisis the symptoms are not very severe. It has been pointed out that occasionally in phthisis pneumothorax seems to actually benefit the tuberculous area in the lung. The physical signs of pneumothorax are as follows: The affected side of the chest is bulged and immobile, and the heart is displaced, especially if the condition affects the left side. Palpation discovers that vocal fremitus is lessened or absent. On auscultation it is found that the breath-sounds are very feeble or absent. The voice is transmitted as a metallic sound, the râles sound metallic, and on coughing there may be metallic tinkling. The percussion-note is tympanitic. In some rare cases the percussion-note is dull. When fluid gathers there is a positively dull note on percussion over the fluid.

Treatment.—Osler says the treatment should be the same as that of pleurisy with effusion. In many cases it is wise to perform paracentesis

without suction to remove air and serous effusion. If pus forms, a rib should be resected and a tube inserted (see Empyema). In pneumothorax occurring during chronic phthisis operation is of great service. In cases with rapidly progressive phthisis it is practically useless.

If the opening into a bronchus or air-cell remains patent, aspiration will not get rid of air; the air will enter into the pleura as rapidly as the aspirator removes it. Incision has dangers of its own: the diaphragm is flapping during respiration and may be injured (Fowler), and when the pleura is opened there is a great alteration produced in the air-pressure in the chest, and the patient may "drown in his own secretions." After incision irrigation is not justifiable, because the fluid may enter a bronchus and produce suffocation (Fowler).

West's rule is a good one*—that is, early incision is dangerous. In an early stage use paracentesis without suction. This will often relieve the patient. If paracentesis does relieve him, wait a while and perhaps repeat the operation if the symptoms again become severe. If paracentesis does not relieve, incise, resect a portion of a rib, and drain. If pus forms, an incision must be made and a portion of a rib resected, to afford exit to the fluid.

Fowler points out that if the lung is bound down by adhesions, incision is dangerous but justifiable. Operation at the proper time often prevents the lung being bound down by adhesions.

Acute Traumatic Pneumothorax.—This is produced by the sudden admission of a quantity of air into the pleural cavity as a result of a wound of the chest-wall. A small quantity of air, or the gradual introduction of considerable air does not, as a rule, produce very serious symptoms. The sudden admission of a quantity of air causes very dangerous symptoms, and even death. A quantity of air may be admitted rather suddenly as a result of an accident or during the performance of a surgical operation which opens the pleura. It sometimes arises during the removal of tumors from the chest-wall, during operations upon the lung, and during empyema operations. As a rule, when pulmonary adhesions exist, dangerous symptoms do not arise, even when the pleura is widely opened, and adhesions exist in 25 per cent. of empyema cases seen by the surgeon.†

It used to be taught that whenever the pleura is opened there is a strong tendency to the development of pneumothorax, but West has shown that the surfaces of the pleura often cohere with a force superior to pulmonary elasticity, and in such cases pneumothorax does not arise.

Symptoms.—When the pleura is opened during an operation or by an injury, the symptoms may be trivial and transitory, may be tolerably severe, may be extremely grave, and the patient may quickly die (Quénu and Longuet). Rudolph Matas sets forth the symptoms as presented by the French observers:‡

The mild symptoms are a weak, slow pulse and irregular, noisy respiration.

The severe symptoms are slow pulse, slow and irregular respiration, and dyspnea, continuing after the anesthetic has been withdrawn.

The grave symptoms are cyanosis; collapse; small, weak pulse; shallow and noisy respiration; and spells of syncope. Death may occur suddenly from inhibition, or later from mechanical asphyxia (Matas).

Treatment.—Various plans have been adopted: suturing the opening in

* Brit. Med. Jour., Nov. 27, 1897. † Rudolph Matas, *Annals of Surgery*, April, 1899.

‡ *Annals of Surgery*, April, 1899.

the pleura; plugging the opening; pulling the diaphragm into the wound in the chest-wall and suturing it; and grasping the lung and suturing it to the wound. Whenever the pleura is widely opened, follow the advice of Matas and use the Fell-O'Dwyer apparatus, and when the operation is completed, suture the lung to the margin of the opening in the pleura with a continuous catgut suture. Parham and Keen have followed this plan and the lung was kept from collapsing.*

The Fell-O'Dwyer apparatus is shown in Fig. 346.

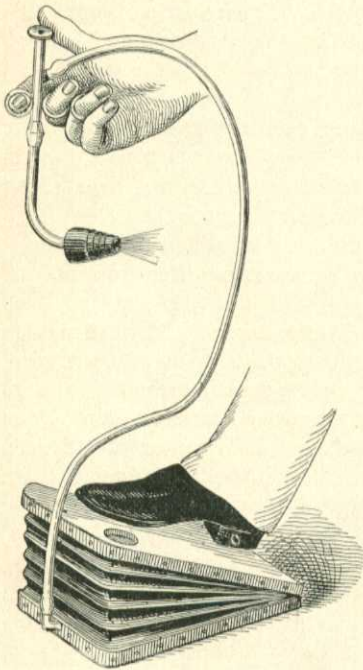


Fig. 346.—The Fell-O'Dwyer apparatus. This illustration shows an early model; since then the bellows has been improved by the addition of a strong wooden frame, which holds it steadily, and is provided with a long arm that acts as a powerful foot-piece for compressing the machine with the least amount of muscular effort.

O'Dwyer's tube is introduced into the glottis and is attached to a bellows, the lung is inflated, respiration is maintained by the use of the bellows, and collapse with all its dangers is avoided.

Contusions and Wounds of the Chest.—Contusions.—A contusion may be trivial and limited to the superficial parts of the chest-wall; it may involve the muscles; it may be associated with fracture of the ribs or sternum or with visceral injury.

Symptoms.—In an ordinary contusion without visceral injury there are considerable pain, discoloration, and often much swelling. The patient prefers to lie upon the back and the respiration is abdominal. After a severe blow upon the chest there is great shock and may even be instant death. The condition of shock so produced is called concussion of the chest. Broken ribs may injure the pleura or lung. After a severe blow upon the chest a limited area of inflammation may arise in the pleura (traumatic pleuritis). Severe visceral injury is announced by positive symptoms. A *contusion of the lung* causes pain, cough, expectoration of bloody mucus, dyspnea, and possibly distinct hemoptysis. Over the contused region the percussion-note is dull and on auscultation crepitus is audible. A limited pneumonia

always follows, but genuine croupous pneumonia may arise.

In **rupture of the lung**, besides the symptoms above noted, there are hemothorax and pneumothorax.

Rupture of the diaphragm causes pain and dyspnea, and often vomiting. The stomach or intestine may pass into the pleural sac. If this happens, there will be a tympanitic percussion-note over the displaced viscus and symptoms

* F. W. Parham's paper on "Thoracic Resection for Tumors Growing from the Bony Walls of the Chest." Read before the Southern Surgical and Gynecological Association, November, 1898.

will vary with the viscus involved. In a case in the Jefferson Medical College Hospital, in which the stomach passed into the left pleural sac, there were persistent vomiting, violent pain in the chest and upper abdomen, great thirst, and displacement of the apex-beat. Such a diaphragmatic hernia may become strangulated. (See page 842.)

Treatment of Contusions of the Chest.—An ordinary contusion is treated as directed in the section on Contusions (page 192), and the chest is strapped with adhesive plaster, as in the treatment of fractured ribs. In concussion of the chest the treatment for shock is applied. It may be necessary to employ artificial respiration for a time. If a diaphragmatic hernia is diagnosed, the abdomen should be opened, the displaced viscera restored to their proper abode, and the diaphragm sutured. The diaphragm may also be reached by resecting several ribs and opening the pleural sac. In contusions of the lung cold is applied to the chest, and any inflammation which arises is treated according to general rules. In rupture of the lung the case may be treated expectantly, but dangerous and continued bleeding or pneumothorax may render surgical interference necessary.

Wounds of the Chest.—Non-penetrating wounds are not particularly grave, and are treated according to general principles, the chest being immobilized. Penetrating wounds are extremely grave, as viscera are apt to be injured. In such a wound an intercostal artery may be severed or the internal mammary artery may be divided. An intercostal artery is rarely divided unless a rib is broken. The surgeon should always examine carefully in order to determine whether an intercostal artery or the internal mammary artery has been divided, and, in doing so, should bear in mind the admonition of Matas—that is, the bleeding from these vessels may be internal, the blood collecting in the pleural sac. The pericardium or heart may be injured (page 284). A wound of the pleura is usually, but not always, associated with a wound of the lung. If the lung is injured, there are usually great shock, pain in the chest, dyspnea, and cough. In a large wound, damage to the lung will be indicated if air is sucked into the wound during inspiration and expelled during expiration, and blood is forced out of the wound by coughing. The lung may be visible or may protrude (*hernia of the lung*). In a small wound it is often difficult and sometimes impossible to determine whether the lung has been injured. Pneumothorax with pulmonary collapse proves it has. Severe hemothorax strongly suggests it. Spitting blood does not prove it. In some severe cases there is no hemoptysis; in some slight bruises the amount of blood coughed up is large. Emphysema about the wound does not prove lung injury. An incised wound of the lung is apt to produce rapid death from hemorrhage, especially if the wound is at the root of the lung. A pistol-bullet or a sporting-rifle bullet is not usually productive of great primary hemorrhage; but infection probably follows, and secondary hemorrhage is apt to occur. The modern military-rifle ball passes through, rarely lodges, is aseptic, and often produces astonishingly little trouble. A pistol-bullet and an old-time rifle bullet may lodge or may perforate.

Treatment.—Bring about reaction as pointed out on page 192.

In an incised wound of the chest, if large, carefully inspect it. If the wound is small, cut down layer by layer until the depths of the wound are reached. Disinfect the wound and arrest hemorrhage. If the pleura is not

open, proceed according to general rules (page 197). If the pleura is found to have been opened, suture it with catgut, close the superficial wound, dress with gauze, and immobilize the chest-wall.

The above proceedings should be carried out whether it is or is not believed that the lung has been damaged, provided there is no pneumothorax and no violent hemorrhage. What course shall be pursued if the lung has been injured by a stab? If hemorrhage does not threaten life and there is no pneumothorax, the patient is kept at rest and observed. If pneumothorax occurs, the pleural sac must be drained by means of a tube, because clots must be evacuated and infection should be anticipated. If hemorrhage into the pleural sac persists, active measures become necessary. The use of ice-bags and drugs is but waste of time. Some surgeons believe that the mere closure of the external wound leads to arrest of hemorrhage, blood accumulating and making pressure. It is true that hemorrhage often ceases after suturing or plugging a wound and strapping the chest, but it is not probable that it ceases because of these measures. Blood in the pleura will not clot for many days. Further, as Le Conte shows, as the blood is forced against the root of the lung, the right heart is engaged, the blood-pressure is raised, and the bleeding continues.*

Bleeding from the lung can often be arrested by inserting the end of a drainage-tube into the pleural sac. In cases where a drainage-tube is inserted into the pleural cavity and free drainage established, the pleura is immediately filled with air, and the muscles of respiration are kept from acting on the lung. The lung contracts by its own elastic tissue, as well as by the pressure exerted by the pneumothorax, and at the same time the presence of the air favors clotting in the severed vessels.† If the insertion of a tube fails, or if the bleeding is rapid and obviously seriously threatens life, several ribs must be rapidly resected and the bleeding part explored. In some cases the bleeding may be arrested by ligation, in some cases by packing a small wound with gauze, in some cases by the suture ligature. In a violent secondary hemorrhage following a gunshot-wound of the lung the author packed the entire pleural cavity with sterile gauze to obtain a base of support, and arrested the bleeding by carrying iodoform gauze directly against the oozing surface.‡ After directly arresting hemorrhage from the lung, turn clots out of the pleural sac and insert a drainage-tube. In a perforating wound inflicted by a bullet, reaction must be brought about, the wound dressed antiseptically, the chest strapped, and the patient kept quiet.‡ If pneumothorax occurs, the pleura should be drained with a tube. If hemorrhage occurs, it should be met as directed above. In a wound in which the bullet has lodged an examination should be made to see if the bullet is under the skin and if it is, it is removed after the patient has reacted. It should always be borne in mind that a pistol-bullet may be deflected by a rib or may pass from the front to the back part of the chest by making a burrow under the skin (*a contour wound*). If a bullet is lodged, no attempt should be made to remove it unless an operation must be done for bleeding, unless the bullet causes trouble, or unless it is felt under the skin. Under no circumstances conduct a long search for a bullet. If emphysema of the chest-walls is moderate, strapping or a bandage will control it; if it is great, make multiple punctures and then

* Annals of Surgery, April, 1899.

† Le Conte, in Annals of Surgery, April, 1899.

‡ Annals of Surgery, Jan., 1898.

apply pressure. In hernia of the lung try to restore the protrusion; but if restoration is impossible or if gangrene seems likely to occur, ligate the base of the protrusion with silk and cut away the mass.

Abscess of the lung may follow ordinary pneumonia. It is apt to follow aspiration-pneumonia. It is usually caused by streptococci or staphylococci, but it may result from pneumococci or colon bacilli. These germs may reach the pulmonary tissue by direct entrance from adjacent organs, by way of the blood or by way of the bronchi and alveoli. Osler tells us that pulmonary abscess may result from the aspiration of septic particles after "wounds of the neck, operations upon the throat," and suppurative lesions of the nose, larynx, or ear.* Aspiration-pneumonia may develop when there is difficulty in swallowing from any cause, when there is profound exhaustion, and when there is palsy or inco-ordination of any of the muscles of deglutition. Cancer of the esophagus may be a cause; so may perforation of the lung by an abscess, wound of the lung, impaction of a foreign body in the lung, suppuration about a focus of tubercle or a metastatic abscess. A pulmonary abscess may be of trivial size or it may be very large, involving an entire lobe. There may be one abscess, several, or many. When suppuration results from aspiration-pneumonia or blood-infection, there are usually multiple abscesses.

Symptoms.—The expectoration is not frequent, but is profuse, and during a paroxysm mouthfuls are coughed up in rapid succession. The expectorated matter is sour or very offensive in odor and contains fragments or shreds of pulmonary tissue, which can be identified as such by the microscope. The patient lies upon the diseased side in order to keep the pus from running into the bronchi and causing cough. When the cavity fills and pus reaches the bronchi, violent cough and expectoration begin, continue until the cavity is partly or entirely emptied, and then subside, perhaps for several hours. If the abscess-cavity is large and full of pus, an area of dullness on percussion can be mapped out. When the pus is coughed out and the air enters, physical signs of a cavity are clear. The x-rays often show the situation of such a cavity.

The course of abscess of the lung is usually acute. There is fever of the hectic type, rapid loss of weight, weakness and rapidity of circulation, dyspnea, pallor, sleeplessness, and great weakness. Gangrene may arise; empyema or pyopneumothorax may develop; very rarely the abscess breaks through the chest-wall; recovery may follow spontaneous evacuation or drainage by coughing up pus; death may result from exhaustion or secondary septic lesions. If operation is performed, from 50 to 60 per cent. of the patients will recover.

The **treatment** is purely surgical (pneumotomy). Make an incision over the cavity. Resect a portion of one or more ribs. Expose the pleura. If the two layers of the pleura are not adherent, suture them together and wait two days. If they are adherent, proceed at once. Search for the abscess with an aspirator needle. When the cavity is found, open into it with the cautery and insert a drainage-tube (page 676).

Gangrene of the Lung.—This term means the putrefaction of a devitalized portion of pulmonary tissue. The tissue is devitalized by the

* See Osler's "Practice of Medicine."

action of pyogenic micro-organisms. Gangrene may follow abscess, bronchitis, or pneumonia, or may be due to diabetes, to embolism of the pulmonary artery, bronchiectasis, tuberculosis, malignant disease, wounds, or the lodgment of foreign bodies. Gangrene may be circumscribed or diffused. There may be one cavity, small or large, or multiple cavities may form. The gangrenous area putrefies, softens, and the softened matter may be expectorated, a gangrenous cavity being formed. In some cases the cavity is, after a time, surrounded by fibrous tissue and obliterated by granulations.

Symptoms.—Expectoration occurs only now and then, but at each seizure a great quantity of matter is brought up and this matter is hideously offensive. Occasionally there is no expectoration. The breath is very foul. The patient, as in lung abscess, lies upon the diseased side. The expectorated matter is mucopurulent, contains particles or shreds of pulmonary tissue, bacteria, and altered blood. The fetor of the pus is much greater than is the fetor of the pus of an abscess. Physical signs may indicate either consolidation or a cavity. There is hectic fever, great exhaustion, deadly pallor, and diarrhea. Pulmonary hemorrhage is not unusual, and complications spoken of in the article upon Abscess may occur. Recovery sometimes ensues, the cavity closing by granulations. Death may take place in a few days. Often the patient lives for weeks, being sometimes better and sometimes worse, dying finally from exhaustion or from the effects of a complication.

The **treatment** is to operate as for pulmonary abscess.

Tuberculous Cavity in the Lung.—Surgical Treatment.—For the past decade surgical thought has been actively directed toward placing on a scientific footing operations for pulmonary phthisis. The matter is still in a transition-stage, and operations at present have but a very limited field of application, although Sonnenberg and others have reported cures. Baglivi, in the seventeenth century, endeavored to tap and inject tuberculous cavities. Hastings and Stuckè did the same thing in the eighteenth century. Mosler, a number of years ago, attempted to treat cavities by introducing a trocar into the cavity and injecting permanganate of potassium solution through the cannula. Patients were not benefited by this procedure. The plan was revived by Pepper in 1874. The results are bad and the operation dangerous. Hillier tried injection of corrosive sublimate into the lung-parenchyma, but the effect of the injections was disastrous. Vidal advocates counter-irritation by the actual cautery and maintains that congestion improves nutrition. When the strength of the patient is well preserved and the pulmonary lesion is circumscribed and slowly progressive, it may be justifiable to perform an operation, open the cavity, and treat it directly (pneumotomy). That pneumotomy might be performed successfully was suggested to surgeons by observing patients recover after sword-thrusts into the lung. Baglivi incised the lung in 1643. Fowler says it is not justifiable to operate if the disease has come "to a standstill." The same surgeon states that the only accessible region is bounded above by the clavicle, to the inner side by the manubrium, to the outer side by the lesser pectoral muscle, and below by the second rib.* This operation does not cure any one, but it may cause

* See the very full and thoughtful article by George Ryerson Fowler on "The Surgery of Intrathoracic Tuberculosis," *Annals of Surgery*, Nov., 1896.

distinct improvement when there is hectic from an ill-drained cavity containing the products of a mixed infection. In an advanced case there is usually more than one cavity, and then the operation is contraindicated. Before attempting it, be sure the case is advanced and that the cavity is single. Locate the cavity by auscultation, percussion, and the x-rays. (See Willard, "Jour. Amer. Med. Assoc.," Sept. 20, 1902.)

Mauclaise says that pneumotomy is only justifiable in circumscribed tuberculous cavities without peripheral infiltration and in pulmonary abscesses.* Bronchiectatic cavities are usually multiple; they are excessively difficult to locate, and treatment by pneumotomy should not be attempted. In the treatment of pulmonary tuberculosis resection of the diseased area has been proposed (pneumectomy). Tuffier successfully performed this operation. Surgeons, as a rule, do not believe in pneumectomy. Reclus voices the general opinion when he says the operation is not required if the area of disease is very limited, as such a condition is frequently curable by medicinal means, and it does no good if the area of disease is extensive.†

It has long been known that pneumothorax might benefit a tuberculous lung. Attempts have been made by Farlanini and Murphy to cure phthisis by the deliberate production of pneumothorax. Murphy injects nitrogen gas into the pleural sac, and believes that the method is of great value. It is maintained that Murphy's operation occludes the lymph-channels, prevents bleeding, compresses the lung, favors the development of fibrous tissue, and leads to healing of cavities. Every third or fourth week 120 c.c. of nitrogen gas are injected into the pleural sac. (See Willard in "Jour. Amer. Med. Assoc.," Sept. 20, 1902; Murphy's paper before Amer. Med. Assoc. in 1898; Lemke in "Jour. Amer. Med. Assoc.," Oct. 14, 21, 28, 1899.)

It has been suggested that in extensive unilateral tuberculosis of the lung resection of a number of ribs will favor cure by permitting retraction of the chest-wall.‡

OPERATIONS ON PLEURA AND LUNGS.

Exploratory Puncture of the Pleural Sac.—Puncture often gives valuable information as to the existence of fluid in the pleural sac and as to the nature of the fluid. The operation must be performed with aseptic care, otherwise a serous effusion might be converted into a purulent effusion, and either a serous or a purulent effusion might be rendered putrid. A large hypodermatic syringe with a long and strong needle is used for exploratory puncture. A slender needle breaks easily and is unsafe. In order to prevent breaking of the needle impress upon the patient the absolute necessity of keeping quiet and avoiding any violent respiratory or general movement during the operation. It is not desirable to stick the lung, although harm rarely results from such an accident. If no fluid is found in the pleura on one trial, several other punctures should be made. What is known as a dry tap may be due to the entire absence of fluid, to encapsulation of fluid in a region not invaded by the needle, to the lodgment of the point of the needle in thickened pleura or in an adhesion, or to blocking of the

* La Tribune médicale, Sept. 21, 1893. † Revue de Chirurgie, Nov. 11, 1895.

‡ Allis, to State Med. Soc. of Penna. in 1891.

lumen of the needle with coagula. Fowler points out that if a person has been recumbent for a long time the upper layer of fluid may be clear while the lower layer is purulent.* The fluid should be collected in a sterile glass tube and subjected to a careful bacteriological study.

Paracentesis Thoracis.—The operation of tapping with a simple trocar and allowing the fluid to flow out through the cannula is no longer practised except in an emergency when an aspirator cannot be obtained or in an early stage of non-traumatic pneumothorax. An aspirator is a much better instrument.

Aspiration.—Aspiration consists in the introduction into the pleural sac of the tip of a hollow needle, the other end of which is attached by means of a rubber tube to a bottle from which the air has been exhausted. The fluid does not run out, but is sucked out, air is excluded, and bacteria do not enter the pleural sac. Fig. 266 shows a pneumatic aspirator. No anesthetic is required. The patient's skin, the instruments, and the surgeon's hands must be thoroughly aseptized. The patient is given a little whiskey, and, unless he is very weak, he assumes a semi-erect attitude with the arm hanging by the side. The trocar is introduced in the fifth interspace, just in front of the angle of the scapula. The surgeon marks the upper border of the sixth rib with the index-finger, and plunges in the trocar just above the finger, thus avoiding the intercostal artery, which lies along the lower border of the rib above. He guards the needle with the index-finger to prevent its going in too far. The fluid is withdrawn rather slowly in order that the patient may escape syncope and violent cough. If the patient becomes very faint, the operation should be abandoned. All the fluid present should not be removed at one sitting—complete removal of a large effusion is not safe. The operation can be repeated if necessary. —After withdrawing the cannula place iodoform collodion over the opening in the chest. In an early stage of non-traumatic pneumothorax perform paracentesis without suction. In non-purulent pleuritic effusion, if the lungs will not expand after tapplings, perform thoracotomy. In some cases aspiration is followed by pulmonary embolism or embolism at a distance. Syncope is a not unusual result. Convulsions occasionally occur. In rare cases the sudden withdrawal of a large effusion is followed by *albuminous expectoration*, as was pointed out by Pinault in 1853. It usually begins from a few minutes to half an hour after aspiration. When this complication arises the pulse is very weak, there is severe dyspnea, cyanosis, cough, and the expectoration of quantities of a yellow, frothy fluid. Riesman ("Amer. Jour. of Med. Sciences," April, 1902) demonstrates that the condition is due to pulmonary edema and not to puncture of the lung. The sudden withdrawal of fluid by aspiration relieves the pressure which was compressing the lung, the lung becomes congested with blood (congestion by recoil, Riesman calls it), the blood distends weakened vessels, and profuse transudation takes place into the air-cells. Most cases recover in a few hours or a day or two. Severe cases die from asphyxia. Terrilon collected 23 cases with 2 deaths. If albuminous expectoration arises dry cup the chest and counter-irritate with mustard plasters. Perform venesection. Give oxygen by inhalation. Administer atropin hypodermatically. Employ artificial respiration if necessary.

* Annals of Surgery, November, 1896.

Thoracotomy is an incision into the cavity of the pleura. It may be merely an intercostal incision, or may be an opening into the chest after resecting a portion of a rib. Often in a child with empyema good drainage can be obtained by an intercostal incision, but in most children and in all adults a rib should be resected. The instruments required for rib resection and thoracotomy are a scalpel, a grooved director, forceps (hemostatic and dissecting), scissors, a periosteum elevator, retractors, a costotome or metacarpal saw, rongeur forceps, drainage-tubes, and needles.

If there is very little dyspnea, ether can be given. If there is considerable dyspnea, chloroform should be given. If there is severe dyspnea, no general anesthetic is admissible. In severe dyspnea the patient is using certain voluntary muscles to aid him in obtaining air. A general anesthetic abolishes the activity of the voluntary muscles of respiration, and so might cause suffocation. In such cases the operation can be done with fair satisfaction after the injection of eucain or after infiltrating the superficial tissues of the chest-wall with Schleich's fluid, or, what is better, preliminary aspiration can be performed. Aspiration will permit of the subsequent administration of a general anesthetic. The patient on whom thoracotomy is to be performed is placed supine, the diseased side being at or over the edge of the table. He must never be placed on the sound side, because he breathes only with that side, and pressure on it may be dangerous.

The arm of the diseased side should be elevated to a right angle with the body. If the surgeon desires to obtain only intercostal drainage, he should make a longitudinal incision about three inches in length at the upper border of the sixth or seventh rib, and the middle of this incision should correspond to the midaxillary line. This incision is carried, layer by layer, to the pleura. If, as will usually be the case, he wishes to remove a portion of a rib, he will make an incision about three inches in length directly upon the outer surface of the rib he wishes to remove, and the middle of this incision corresponds to the midaxillary line. Some surgeons resect a portion of the fifth rib, some remove a bit of the eighth rib, and Munro* shows that at the level of the eighth rib there is no danger of injuring the diaphragm. By many operators a portion of the seventh or eighth rib is removed in front of the line of the posterior axillary fold.

I agree with Hutton that a portion of the sixth rib in the midaxillary line should be removed.† The reasons given by Hutton for the selection of this rib are: (1) It is over the portion of the lung which expands last. An empyema is drained only partly by gravity, and the fluid is really forced out and the cavity obliterated by lung expansion. If an incision is made anterior or posterior to this point, the expanding lung will block the drainage-opening, and a pus-cavity without drainage will remain in the midaxillary line. (2) Such an incision permits a patient to lie on his back without making pressure on the drainage-tube.

The periosteum of the outer surface of the rib must be divided in the

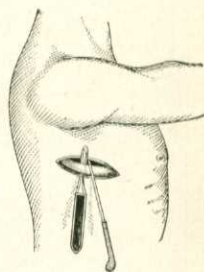


Fig. 347.—Resection of a rib (Esmarch and Kowalzig).

* Medical News, Sept. 2, 1899.

† See W. Menzies Hutton on "Empyema," in Brit. Med. Jour., Oct. 29, 1898.

same direction as the superficial incision. The exposed rib is stripped of periosteum front and back by means of a periosteal separator, and with the periosteum at the lower border of the rib the intercostal artery is lifted out of harm's way. The rib can be divided by means of cutting forceps, a chain-saw, or a Gigli saw. I prefer a costotome as it accomplishes the section most rapidly. The usual method is to push a periosteal separator under the rib, and saw the bone in two places by means of a metacarpal saw (Fig. 347). An inch or more of the rib should be removed. The intercostal artery is ligated at each end of the incision, the periosteum is removed and the pleura is opened. The object of removing the periosteum is to prevent the rapid formation of bone which might narrow the opening and interfere with drainage. The actual opening of the pleura is carried out in the same way in intercostal incision and after rib-resection. A grooved director is pushed into the pleural sac, and the opening is enlarged by means of the forceps and the finger.

The finger removes all masses of tuberculous material or aplastic lymph within reach. If the finger finds the lung bound down with dense adhesions so that it cannot expand, simple rib-resection will not cure the patient, and Estlander's, Schede's, or Fowler's operation should be done. Some surgeons advocate immediate irrigation after opening an acute empyema, but this procedure is unsafe. It is true that in most cases irrigation does no harm, but in no case will it sterilize the cavity, and in some cases it is very dangerous. The pleura is very susceptible to the action of irritants. This is especially true of young children. It happens occasionally that the injection of the blandest fluid is followed by intense dyspnea, great shock, disturbances of respiration and circulation, convulsions, and even death (Quénu). The convulsions which occasionally follow pleural irrigation were called by de Cereville *pleural epilepsy*. In putrid empyema it is proper to irrigate. Irrigation will remove part of the actively poisonous putrid matter, and the retention of putrid matter is a greater danger than irrigation. It used to be rather a common custom to make a counter-opening by cutting down upon the long probe pushed against the chest-wall after being introduced through the incision, but a counter-opening is of no particular use. A drainage-tube about two inches in length is introduced and stitched in place. The tube must not be long enough to touch against the lung. A safety-pin is clamped upon the tube to keep it from slipping into the chest. A tape should be fastened to each side of the tube and tied about the chest to prevent it from slipping out. Arrest bleeding, suture the skin, dress with gauze, wood-wool, and a binder, and have the dressings changed as soon as they become soaked at one point. Several times a day change the patient's position. At each change of dressings direct him to lie on the diseased side for half an hour, and with the foot of the bed raised for half an hour. Healing takes place by ascent of the diaphragm, expansion of the lung, and retraction of the chest-wall. Expansion of the lung is favored by expiratory acts; hence cause the patient several times a day to blow into a wash-bottle filled with water. Remove the drainage-tube when the discharge becomes thin and scanty (about the eighth or tenth day, as a rule). If an empyema ceases to improve and remains stationary for four to six weeks after it has been drained, firm adhesions exist. The surgeon must perform the operation of Schede, Estlander, or Fowler.



Thoracoplasty (Estlander's Operation) is employed in old cases of empyema in which drainage has failed, and in cases with retracted chest-wall, collapsed lung, thickened pleura, and cavities whose rigid walls will not collapse. The procedure recognizes the fact that after pus is evacuated, if the lung is adherent, it cannot expand to fill the space once occupied by fluid, and that the rigid chest-wall cannot fall in as a substitute for the lung. It seeks to destroy the rigidity of the chest-wall and to permit it to collapse and thus obliterate the cavity of the empyema. When the surgeon resects a rib and finds a cavity with uncollapsible walls, or a lung bound down with firm adhesions, he should perform thoracoplasty. This operation causes the obliteration of the cavity by collapsing that portion of the chest-wall overlying it. The cavity is usually in the upper or central part of the pleural space. The instruments required are the same as those for resection of a rib. The position is the same as that for rib-resection. The length of the incision depends on the size of the cavity.

The surgeon usually removes portions of the second, third, fourth, fifth, sixth, and seventh ribs. Make a transverse incision along the center of an intercostal space, and through this incision remove the ribs above and below by the method set forth on page 674 (the removal of six ribs will require three incisions). Instead of this incision, we can make a vertical incision or a U-shaped flap. Always take away the periosteum in order to prevent reproduction of the ribs. In cavities which are surrounded by firm adhesions, and in old cases in which the pleura is greatly thickened, irrigation is safe. If the cavity is small, it should be packed with iodoform gauze and allowed to granulate; if large, it should be drained by a large tube, the skin being sutured by silkworm-gut.

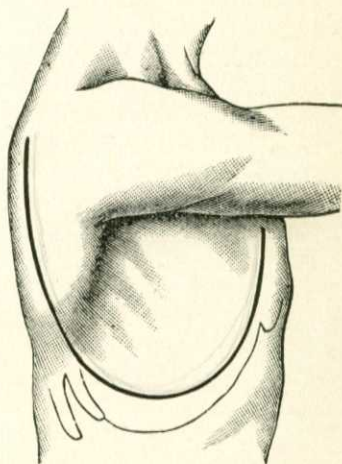


Fig. 348.—Incision for Schede's operation of thoracoplasty (Esmarch and Kowalzig).

Schede's Operation.—Schede showed that when the pleura is much thickened even Estlander's operation will not permit the chest-wall to collapse and fill the cavity once occupied by the fluid. The instruments used are the same as for Estlander's operation. A U-shaped flap is made from the level of the axilla in front to the level of the second rib and between the scapula and spine behind. The lowest level of this incision corresponds to the lowest limit of the pleura (Fig. 348). The flap is loosened and raised, and the scapula is lifted with it. The ribs from the second rib down and from the costal cartilages to the tubercles are removed, along with the intercostal muscles and the pleura. This is accomplished by cutting with bone-shears and scissors. Hemorrhage is arrested. The pleura is curetted. A drainage-tube or a piece of iodoform gauze is introduced, and the raw flap is laid against the visceral layer of the pleura. The superficial incision is sutured, except at the point where the tube of the gauze emerges. The mortality from Schede's operation is from 15 to 20 per cent.

Total Pleurectomy or Pulmonary Decortication (Fowler's Operation).—In the spring of 1893 de Lorme performed some experiments on dogs looking to the development of the operation. In October, 1893, George Ryerson Fowler, without any knowledge of de Lorme's investigation, operated on a man and cured a chronic empyema. The French surgeon's first operation was months later. Extensive rib-resection is practised. This is better than de Lorme's trap-door flap, which causes pneumothorax, a condition which retards lung expansion. The thickened pleura is removed from the chest-wall, lung, pericardium, and diaphragm, any sinus is extirpated, and all granulation tissue is taken away. This operation completely removes all infected tissue. Fowler makes a report of 30 cases. Eleven cases were completely cured. In 17 cases the empyema was cured, but 6 of them had tuberculosis. There were 3 deaths. The combined statistics of Fowler, de Lorme, and Cestan show 35.7 per cent. cured, 19.7 per cent. improved, 33.9 per cent. not cured, and 10 per cent. died (Kurpjweit, in "Beiträge zur klinischen Chirurgie," Bd. xxxiii, H. 3).

Pneumotomy for Abscess of the Lung.—The instruments required are scalpels, hemostatic forceps, dissecting forceps, a dry dissector, retractors, a periosteum-elevator, a metacarpal saw, scissors, needles (curved and straight), and a Paquelin cautery.

Operation.—Give chloroform or use a local anesthetic. Place the patient recumbent with the shoulders a little raised. Make a U-shaped flap over the seat of disease. If the intercostal spaces are wide, cut down in a space to the pleura. If they are not wide, resect a portion of a rib. If it is found that adhesions do not exist between the pulmonary and costal layers of the pleura, stitch these layers together with catgut and postpone further operation for forty-eight hours. If adhesions exist, proceed at once. Chloroform can be put aside when pleura is exposed. Fowler calls attention to the fact that lung-tissue is so insensitive that the administration of an anesthetic can be suspended as soon as the pleura has been opened. Incise the agglutinated layers of the pleura, and pass an aspirating-needle into the lung in various directions. When the abscess is located open it with the cautery. Carry the Paquelin cautery slowly into the lung in the direction of the abscess-cavity. The cautery knife should be at a dull-red heat.

When the cautery opens the cavity of the abscess, withdraw the instrument and insert a drainage-tube or a bit of iodoform gauze, and suture the flap of superficial tissue. If the abscess is not found after one or two punctures with the aspirating-needle, abandon the attempt.

Tuffier explores for an abscess by what he calls *décollement of the parietal pleura*. He exposes the parietal layer of the pleura, passes his hand between this layer and the chest-wall, strips the pleura off over a considerable area, and is able to feel the lung below and thus determine its condition.