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The treatment of empyema thoracis

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THE TREATMENT OF EMPYEMA THORACIS

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The Treatment of Empyema Thoracis

The chaotic condition in which the treatment of empyema found itself during the World War was taken account of by the Surgeon General of the United States; whereupon, in 1918, he appointed an empyema commission to study the situation, and advise thereupon. After some months, the commission was able to suggest drastic measures changing the treatment and management, most noteworthy of which was the postponement of the time of operation. The reformation, however, did not succeed in accomplishing all that was anticipated. Instead, it left the situation in very nearly as tumultuous a condition, in regard to the choice of operation, as it had been previously in regard to the time of operation. The last word has not, as yet, been spoken, and, from all appearances, it looks as though considerable time would elapse before any universal opinion can prevail. Needless to say, there are various types of cases which, in the opinion of many, require different modes of treatment. Whether this opinion will continue indefinitely, or not, remains to be seen.

Before a consideration of the various types of treatment is attempted, it would be well to take into account a snapshot of the various types of empyema which might obtain anatomically. First, there could be a total, or general, empyema...
Treatment of Empyema Thoracis involving the entire pleural cavity, and causing more or less collapse of the lung. (See Figure I.)

On the other hand, there could be the sacculated empyema, of which there are several varieties. One of these is the so-called perietal empyema, occurring between the lung and the chest wall. (See Figure II.)

Another, the mesial variety, occurs between the lung and the mediastinal pleura. (Figure III.)
Another type is the supra-diaphragmatic occurring between the lung and the diaphragm. (See Figure IV.)

Still another variety is the interlobar empyema which is self-explanatory. (See Figure V.)
Treatment of Empyema Thoracis

Empyemas are classified according to the position of the lung or pleura involved, as, for example, apical or lateral empyemas. Sometimes, classifications take into account whether or not the empyema is adherent. An interlobar type of empyema, for example, is usually non-adherent; whereas, a lateral, apical, or supra-diaphragmatic is usually adherent.

One is virtually forced into considering the etiology of empyemas before one can satisfactorily begin treatment. Just as with a great many other diseases, the etiology is not constant, but varies widely. It should not be forgotten that the etiology varies according to whether the empyema is acute or chronic. Pneumonia is, of course, the most common cause of acute empyema thoracis. Other causes are gangrene of the lung, septicemia, influenza, whooping cough, measles, tuberculosis, and primary (idiopathic) empyema. The most natural route of entrance of organisms post-operative following general anesthesia would be by inspiration of the oral secretions. It is probable that many empyemas develop without well-defined clinical manifestations of an abscess or gangrene of the lung. The explanation is this, that an aspiration broncho-pneumonia follows the operation. In explanation of this point, Pilot says that usually with liquifaction necrosis by the anaerobic bacteria, and with the formation of a pulmonary abscess, the patient experiences typical cold symptoms and the usual signs.
Treatment of Empyema Thoracis

tient expectorates typical foul sputum on the twelfth to fifteenth day. In a case of his, he thinks this usual manifestation was prevented by the rapid extension to the pleura, and the quick formation of fluid which collapsed the lung. He observes, further, that, apparently, the empyema was not an extension from the peritoneum on account of the organisms found. Instead of being of the type of B. coli, or other intestinal organisms, they were like those observed in the oral cavity; thus his explanation.

Lastly, but probably not least important from an etiological standpoint, is the consideration of a recognized, demonstrable anatomical curiosity, that is, that there is some anatomical connection between the body cavities, as, for example, between the peritoneal and pleural cavities, or between the two pleural cavities. Whether this plays a part in many, or in only a few of the pleural infections, is not known; but, it is not improbable that it is much more important than has been hitherto recognized.

Acute empyema thoracis is not the surgical emergency it was once considered. Mortality statistics show very definitely that delayed operation materially lessens the death rate. Three very definite advantages are claimed by Hudson for de-
Treatment of Empyema Thoraces

6.

layed operation; first, the delay allows the patient to acquire a partial immunity; second, it allows the patient to recover from the residual toxemia of his pneumonia; and, third, it allows time for sufficient adhesions to form, thereby localizing the pleuritis and stabilizing the mediastinum. By acceptance of the wisdom of deferred operation, until well beyond the period when pulmonary inflammation may be expected to have subsided, we find that the mortality reduction is from forty per cent to five per cent. On this point alone, that of deferred operation, there is absolute agreement in medical ranks; on all other points in empyema management, there is disagreement.

Immediate operation has been relegated to the bier of abandoned procedures. Ambrose Lockwood says, "Few diseases have perplexed the profession so generally since the earliest times, as has empyema." Quoting further, "Even in this advanced era of medical development, there is no agreement as to the treatment, as is evidenced by the various methods advocated, the persistent incidence of chronic empyema, and the extreme variations in mortality." Hippocrates first recognized the disease, and advised intercostal incision, or trephining of the rib for drainage. Galen, the inventor of the aspirating syringe, advised aspiration. The pertinent questions are, the mortality
Treatment of Empyema Thoracis

rate, the length of illness or disability, and the incidence of chronic empyema; therefore, the method used must, of necessity, be based on the individual operator's experience, in the opinion of Henry Hudson Junior. Obviously, the selection of the type of case is a very important element, especially as regards statistical compilation. Difference of opinion exists between the advocates of closed drainage, and those of open drainage. Suermondt thinks that the two methods should supplement each other.

The methods of treatment expounded by various surgeons include, first, simple aspiration; second, closed drainage (intercostal), two types of which are closed drainage without rib resection, and closed drainage after rib resection, the mortality rate of the former type being twice that of the latter; third, open drainage. There are, in general, two types of thoracotomy which are available as procedures in the operative approach. The first is without the division of either bone or cartilage; the second is with the division or resection of part of the thoracic cage. The former type is applicable only before the chest wall has become rigid as the result of pathological processes. The advantages of the first method, the approach by an intercostal incision with wide retraction of
Treatment of Empyema Thoracis

the ribs, are, that it is accompanied by little shock; that the exposure with good rib retraction is ample; that, all parts of the pleura, the mediastinum, and the pericardium being accessible, much time is saved; that the apposition of the parts is almost perfect, pleura being made to join pleura with serous surfaces in contact; that no important nerves are cut; and that healing is rapid. The single disadvantage of this procedure is that, when drainage is required, it must usually be provided through another, though small opening. As concerns the second method, resection of part of the thoracic cage, there are three types, first of which is rib-resection, either single or multiple, two types of which are sub-periosteal rib-resection and resection of the rib with its periosteum; second, trap-door opening in the thoracic wall, either temporary or permanent; and third, rib section supplementing an intercostal incision. Advantages of this method are that it permits excellent exposure and great elasticity of the walls of the wound; that it allows of rapid operation; that it yields little post-operative deformity; and that it is applicable in acute cases as well as in chronic ones.

In making a diagnosis of acute empyema thoracis, it is wise to suspect any pneumonic patient, inasmuch as it
Treatment of Empyema Thoracis

occurs in from four to five per cent of all pneumonia patients. Physical examination may show any of the following points: thoracic asymmetry with scoliosis; bulging interspaces; limited excursion of the affected side; dull or flat percussion note; displacement of the heart away from the affected side; absent or diminished breath sounds; tubular breathing, if the effusion is great; absent or diminished tactile fremitus; bleating character of the spoken voice; decreased radiability; a presence of pus on diagnostic thoracentesis; and definite diagnostic shadows on fluoroscopy.

Just a word in regard to the type of anaesthesia needs to be said. Of course, general anaesthesia may be used, and its indications and contra-indications are quite generally known. Among the advantages of local anaesthesia, according to Lilienthal, is the fact that the patient is fully conscious, and can often be of great assistance to the operator. In intra-thoracic work, he can cough or strain, distending the lungs at will. He can change his position, at request, for the convenience of the operator, avoiding the break in asepsis and the other annoyances of changing the posture of a narcotized patient. There having been no narcosis, food and drink may be taken soon after the operation. The aspiration of septic
Treatment of Empyema Thoracis

matter or blood from the mouth, possibly coughed up from a
diseased lung, is practically avoided. Some of the disadvan-
tages of local anaesthesia are that, in certain operations
on the pleura, as, for example, acute and subacute empyema,
an unavoidable cough reflex may be embarrassing. Vomiting may
appear, and be as troublesome as it is after general anaes-
thesia. Local is contraindicated in extremely nervous patients.
In injecting the area, it is well to take into account the
following points. The skin is sensitive, and must be treated
accordingly. It is stated by Lennander that "all internal or-
gans receiving their nerve supply only from the sympathetic
and from the vagus below the branching off of the recurrent
nerve have no sensation". The subcutaneous connective tissue
and aponeurosis show variations, and should be treated, or
not, according to necessity. As a rule, however, it is found
best to inject the deep fascia. The muscles are not painful
when cut, but their rough manipulation, as by retractors,
often gives rise to a dull aching sensation, different from a
sharp pain. The contraction following the division of an
important muscle often produces a disquieting and depressing
sensation. The periosteum is sensitive, and must be anaesthe-
tized either by direct injection or by nerve blocking. The
Treatment of Empyema Thoracis

11.

Ribs and cartilages, when denuded of periosteum, may be cut, scraped, or chiseled without pain. Peristomal pleura may, or may not be sensitive. The lung and visceral pleura are not sensitive to pain, but arteries and their sheaths are.

In Hudson's clinic, the only two procedures used are first, intercostal, closed drainage, and second, rib resection with open drainage. The first procedure is used on those patients who are so ill that the more extensive rib resection is to be avoided because of trauma and shock; it is used also in infants under one year, as a primary procedure, and in those patients with a very thin exudate and with a culture showing an organism other than the pneumococcus. The procedure followed in his clinic for the performance of intercostal closed drainage is this: the approach is made in the seventh or eighth interspace in the mid-axillary line following infiltration with one per cent novocaine. A one-half inch skin incision is made, and a trocar is plunged into the cavity after aspiration has verified the localization of the cavity. The stylet of the trocar is replaced by a fenestrated rubber catheter, following which the trocar cylinder is removed, and the catheter clamped. Gauze and imbricated adhesive are applied, and the catheter is led into a vessel below the level of the fluid contained
Treatment of Empyema Thoracis

the catheter is then unfastened, and the closed system is established.

Rib resection, with concomitant inspection and palpation of the empyema cavity, is the other method used in Hudson's clinic, and it seems altogether satisfactory. The post-operative hospitalization is shorter in this type of operation, and the proportion of secondary operations is less; also the mortality is lower, eighteen per cent to nine per cent. Ultraviolet therapy, as an adjunct to this type of operation, has more value, apparently, than it has in the other type.

Roeder advocates a gauze pack as another method of treatment. In defense of his innovation, he says, "One of the principal reasons for the origin of the closed method was the thought that air in an infected pleural cavity was detrimental, mainly through preventing an expansion of the lung. The presence of air in an infected pleural cavity has never been proven to be harmful, and the average application of the closed method of drainage rarely prevents the ingress of air." He concludes that it is not the presence of air, but rather the lack of drainage that is the important consideration. By means of his gauze pack, he is able to cause an obliteration of the cavity in from ten to thirty days if the visceral wall of the cavity
Treatment of Empyema Thoracis

is not too thick. The advantages of the gauze pack method are enumerated by Roeder as follows: first, it holds the lung steady following the operation, which, of itself, is most comforting to the patient; second, it clears the exudate rapidly from the walls of the cavity; third, it breaks up the numerous small abscesses in the periphery of the lung; fourth, it eradicates external purulent drainage almost completely, after forty-eight hours; and fifth, it obliterates the cavity at least as rapidly as does any other method. He notes, on the other hand, certain disadvantages, first that the pack must be changed daily by some one experienced, and, second, that the first change post-operative is distressful without light anaesthesia. For the average case, it is necessary to pack the cavity for from seven to ten days with gauze, impregnated with bismuth iodide.

Engstad\textsuperscript{9} produces an effect of vacuum drainage by a type of apparatus altogether different from the ordinary water-seal drainage, which is illustrated below.
Treatment of Empyema Thoracis

His method is to remove the valve stem of an inner tube with a surrounding oval of rubber about three by four inches. To prevent leakage, he glues this to the chest wall with rubber cement. Next, he introduces a tightly fitting rubber catheter into the thorax through the valve stem. By removing pus and air through the tube, using an ordinary Luer syringe to obtain suction, he is able to form a partial vacuum which he maintains by occluding the tube with a hemostat. This negative pressure lasts about four days, and can be renewed according to circumstance.

A method based on a rational sounding theory is advanced by Fenton. The principle on which his method is based is this: a partial vacuum produces hyperemia; a dilatation of the engorged vessels follows, and a flow of serum is promoted through their walls, and into the empyema cavity. This serum provides the positive antiseptic agent required to overcome the infection. It bathes the cells of the affected area, and eventually collects in the empyema cavity, carrying dead bacteria and toxins with it. The lung expands under the influence of the vacuum, and allows the infection to clear up as well. The apparatus consists, fundamentally, of a fenestrated rubber tube, connected indirectly to a Luer syringe. The
rubber tube passes through a sheet of rubber which is drawn well up on the rubber tube, and tied. The rubber sheeting is plastered on its under surface with zinc oxide paste to prevent any leakage. Where the rubber tube penetrates the chest wall, a piece of glass tubing is inserted into its lumen to prevent collapse. The diagram below shows the connections of the rubber tube to a catch bottle, and then to a syringe, with a side connection, interpolated between them, leading to a pressure-regulating manometer which is made of a glass funnel covered with rubber sheeting. The apparatus is not difficult to remove, and should, therefore, be cleaned every day.
A vacuum drainage method of greater simplicity is offered by Mansur. An ordinary Wilson tube is prepared as follows: over its external surface (the larger flange side), is placed a sheet of rubber which is attached at one side only, using rubber cement. This simple procedure makes a one-way valve-trap which, when placed in the chest wall, will be found to offer no hindrance to the escape of pus and air from the empyemic cavity, but will allow nothing to re-enter it. The tube is now further prepared just before introduction into the chest wall by having its smaller flange side rolled up, and held by a hemostat to facilitate its easy introduction into a small chest wall opening. Then, after selecting a suitable site, usually in the mid-axillary line, the skin and deep structures are infiltrated with a local anaesthetic. The rib is resected for a short distance. A sponge is held in the left hand while, with the right hand, a blunt forceps is forced into the empyemic cavity. The jaws are separated enough to make a three-quarters-inch opening. Immediately covering the wound with a gauze sponge, held in the left hand, to prevent immediate escape of the pus, the free hand introduces the valve under the sponge into the chest wall. The operation of the valve may now be observed. The patient coughs slightly, and,
Treatment of Empyema Thoracis

As this increases intra-thoracic pressure, quantities of pus and air rush out through the valve; then, as the thoracic wall relaxes, there is produced an intra-thoracic vacuum. The rubber tissue cover of the tube will then be observed covering the tube opening tightly, through suction. Coughing will be frequent enough to maintain a constant intra-thoracic pressure. If the tube is allowed to remain in place for about four days after it has lost its effectiveness, (usually a matter of several weeks), then collapse of the lung need not be feared. Replacing the valve will correct the collapse, however. In double empyema, this treatment will prove most valuable.

At the New Haven Hospital, L. G. Foster uses a method on acute empyema cases consisting of thoracentesis, delayed partial costectomy, and constant suction tube drainage. Singleton has a method of inserting a trocar and cannula in the eighth interspace in the mid-scapular line, and of allowing the cannula to remain in place, stitched to the skin. A tube connection, filled with sterile water, is led to a large bottle beside the bed, and the end placed under water, thus retaining a vacuum, with siphon effect. The cannula is allowed to remain about ten days, and is then replaced by a rubber tube.

There are as many different treatments for acute
empyema as there are authors discoursing on the subject. Most are too complicated. In some instances suction is obtained, and maintained by pieces of apparatus too cumbersome to use in the average institution. Some even have part of their apparatus leading down through the floor into the basement. Some have a suction apparatus so strenuous that it is responsible for much of a patient's pain. Demme is trying to prove that any empyema case will do at least as well with his method as it will with any other. His method is this. Remove fifty to one hundred cubic centimeters of pus, and replace that volume with a like volume of air, repeating this procedure until all the pus has been removed. The aspirating needle is put into the dependent part of the cavity. The aspiration has to be repeated on an average of three times, but is painless if done properly, and is much preferred by the patient who would rather undergo almost any number of aspirations, if need be, than submit to a major surgical procedure. Allen has made a statement, substantiating the principle of air replacement. He says that, early in the course of the disease, it would seem advisable to replace each syringe of aspirated fluid with a syringe of air, that intrapleural pressure be kept stationary. A sudden withdrawal of pressure from an actively hyperemic membrane must
Treatment of Empyema Thoracis

result in an engorgement of this membrane with blood, and a rapid sucking up of toxic material into the circulation. The lymph vessels are wide open. Bacteria and their toxic products are limited to the endothelial covering of the pleura by intrapleural pressure, mechanically closing these small vessels. A sudden release of pressure, and the membrane becomes engorged with blood, with a resultant overdose of toxin and bacteria liberated in the blood stream.

The sequela of acute empyema can be enumerated as follows: first, death, due to pressure caused by rapid increase in size; second, chronic empyema; third, perforation of the empyema wall, with formation of secondary sinuses, attended by destruction of lung tissue; fourth, bone infection with necrosis; fifth, empyema necessitatis. Just a word is necessary to cover empyema necessitatis. It is one of the natural terminations of empyema, but its mortality is high. The most favorable is when the pus is evacuated spontaneously through a bronchus. It may perforate the esophagus, the peritoneum, the pericardium, the stomach, or the chest wall. When it perforates the chest wall, it may be manifest as a pulsating tumor in the chest wall. Rarely, it may pass down the spine and along the psoas into the iliac fossa, and simulate a psoas or
Treatment of Empyema Thoracis

Lumbar abscess. Cases are on record in which an empyema has passed even further down, and pointed at the ankle.

Briefly, the cause of chronic empyema is either inefficient drainage, foreign body, failure of cavity obliteration, or tuberculous pleuritis. Chronic empyema occurs either as delayed healing, or as recurrence following drainage. Emerson classifies chronic empyema as follows: first, latent or undrained empyema; second, delayed healing, following early drainage; third, persistent, or recurrent empyema, following drainage. Carelessness in examination is responsible for the cases in the first division of his classification. Failure to obtain pus on diagnostic aspiration is the main manifestation of this carelessness, and is due to failure of inserting the needle deeply enough. He states that one-half of chronic empyemas are due to the second division in his classification, first because of partial healing of the drain hole; second, because of failure to secure dependent drainage; third, because of inadequate drainage of secondary pockets; and, fourth, because of incomplete irrigation of secondary pockets. The third division of his classification is more often persistence than recurrence. The cavity may enlarge after the sinus closes. In attempting to divine the
Treatment of Empyema Thoracis

causes of this third division, he has listed certain factors in the following order: first, reinfection (rare); second, early closure of the drainage sinus; third, associated pathology, such as multiple abscesses and bronchial fistulae. These fistulae are apt to become chronic, if the cavities are large, by preventing the inflating action of the increased intratracheal pressure during coughing, straining, etc., and also by reinfecting the cavity. The chronicity may be augmented if the fistulae become lined by epithelium from the mouth of the bronchus. The fourth of the factors that Emerson has listed as causative of persistent, or recurrent empyema is persistent infection in the pleura; fifth is tuberculous pleuritis (nine per cent of all); sixth is foreign bodies, as, for example, segments of rubber tubing, fragments of necrosed rib, bismuth paste, ears of corn, sticks, teratomas, echinococcus cysts, bullets, etc.; seventh is actinomycosis; eighth is massive compression of the lung; and ninth is fibrosis of the lung. Most concisely, the symptoms of chronic empyema are chronic productive cough, with associated manifestations of sepsis such as anemia, tachycardia, multiple arthritis, clubbed fingers, and nephritis.

The cardinal principles in the surgical management
Treatment of Empyema Thoracis

of chronic empyema are to avoid extreme surgical risks; to preserve structure and function, as far as possible; to select reconstructive, rather than mutilating operations; and to use conservative methods when in doubt. A number of different procedures is available. They are discussed below in the order of their severity. The first, and least severe, is preliminary aspiration, with irrigation by the closed method. Preliminary aspiration should be done in every case. If tubercle bacilli are found, no open drainage should be done. (Sterile pus and many mononuclears are presumptive of a tuberculous lesion. In a case like this, repeated aspirations should be done when necessary to relieve the pressure, or aspirations should be done with irrigations, using some good antiseptic solution. Irrigation should not be done, if the pleuritis is simple, that is, if it is not accompanied by thickening of the pleura.) The second procedure is simple open drainage. Simple open drainage is indicated in cellulitis of the chest wall, in removing foreign bodies, in osteomyelitis of ribs, and in cases in which there is a large bronchial fistula. Irrigation can be used safely, with an open operation, even in the presence of a large bronchial fistula. After removing foreign bodies, the use of Wolf's
bottles to get expansion and obliteration of the cavity is indicated. In regard to intercostal open thoracotomy, Emerson says that its use may be justified as a temporary expedient to relieve pressure and circulatory embarrassment quickly in large, massive empyemas, with the condition of the patient very unfavorable. The third procedure is open drainage and exploration of the cavity for foreign bodies. The fourth is a decortication operation. This type of operation is indicated when the failure of obliteration of the cavity is due only to lung compression by a thick, fibrous capsule. It is to be done, however, only when irrigation fails to promote recovery. Good results are not obtained if it is done in tuberculous pleuritis. Lilienthal's non-deforming operation is less formidable, and less dangerous than the Schède, the Estlander, and the Dolorme-Fowler operations. It is indicated in those patients who, having cavities and discharging sinuses, persisting for more than two months after drainage for empyema, and unsterilizable by the Carrel-Dakin method, reveal on examination by the vertical fluoroscope, large rigid cavities and a profuse discharge. This operation of Lilienthal may be described or classified as a major, non-collapsing thoracoplasty. The technique is as follows: the approach is made through a
Treatment of Empyema Thoracis

long, seventh interspace incision, beginning behind the costal angle and extending to the cartilage. From one to four ribs are divided upward, and sometimes downward, at the posterior angle of the wound. A powerful automatic rib-retractor is necessary. The lung, bound down by adhesions, is liberated by incision through the confining membrane which may be removed if there is an easily found line of cleavage. The lung is expanded by intra-pharyngeal insufflation, and should reach the chest wall. Drainage is secured through the original sinus, enlarged for the purpose, the new surgical wound being closed by interrupted sutures of chronic catgut through the muscles, but without the periosteal sutures. The after treatment consists of strenuous blowing exercises. The fifth available procedure is known as plastic operation, consisting of four types. There is the Estlander type, or simple rib-resection; there is rib-resection and excision of the parietal pleura; there is a plastic operation with muscle or skin transplant; and there is extra-pleural thoracoplasty. Jones advises thoracoplasty for empyema with bronchial fistula, and in empyema cases in which there is a non-collapsible cavity due to intra-pleural adhesions within, which prevent lung expansion, and a rigid roof, the chest wall, without. His
two main considerations in thoracoplasty are adequate exposure and a good anaesthetic, either nitrous oxide or para-vertebral block. The plastic operations for chronic pleuritis are indicated in cases which fail to respond to a thorough course of irrigation management, those cases in which there are large sterile empyema cavities which fail to obliterate because of thickened pleura, or in cases in which there is extensive cavitation in the lung itself, with intrinsic fibrosis and contracted lung, or in cases of tuberculous pleuritis.

The least formidable operation in this group is that of Ratlender. It consists of the removal of portions of one or several ribs, with a view to rendering the external wall of the suppurating dead space elastic and to allowing it to be depressed and brought in contact with the collapsed lung. Schede's operation was to obliterate larger cavities, resulting from complete contraction of the lung. It affected a complete collapse of the chest wall. It is now obsolete, and is replaced by the para-vertebral extra-pleural thoracoplastic operation of Sauerbruch.

A diagnosis of tuberculous empyema can be made reasonably safely if proven by biopsy or the demonstration of tubercle bacilli, if there is a clinical picture of tuberculous
Treatment of Empyema Thoracis

Empyema, if there is an empyema in a patient with an active tuberculous focus, or if there is an idiopathic empyema or an empyema in a patient having a preceding idiopathic pleurisy with effusion. In treating tuberculous empyema, the treatment is found to depend on the type of case; first, whether the cavity is open or closed; second, whether the exudate is serous, tuberculous, purulent (sterile), purulent from mixed infection, or hemorrhagic; third, whether the lung expands or remains collapsed upon withdrawal of the fluid; fourth, whether the fluid persistently reappears after each aspiration; and fifth, whether it is complicated by bronchial fistulae.

The treatment of purulent or serous, tuberculous empyema in the early stages is essentially the same, that is removal of enough fluid to relieve respiratory and circulatory embarrassment. Not enough should ever be removed to cause the tuberculized lung to expand. If there is danger of expansion of a tuberculous lung, the fluid should be replaced by nitrogen gas. If there is little or no improvement, radical extra-pleural thoracoplasty may be resorted to. Should this be found necessary, all the fluid should be aspirated from the cavity, the day before operation. If a patient with a sterile exudate is subjected to an open thoracotomy, a
mixed infection will result, and this necessitates an amount of radical surgery to which the patient should not be subjected. When there is found to be a tuberculous lesion near the pleural surface of the lung, twenty per cent argyrol solution should be substituted for Dakin's solution.

Closed empyema with mixed infection should be treated by the closed method if possible. If the closed method fails, the cavity can be sterilized and obliterated by the many-stage open method that is used in cases of non-tuberculous chronic empyema. Treatment of chronic tuberculous empyema, complicated by mixed infection, incident to an open thoracotomy, is practically the same as that used in the ordinary post-pneumonia and post-influenza type of chronic empyema, that is the many-stage open operation with dekination of the cavity until sterile, and closure after seven consecutive, negative cultures have been obtained. The tuberculous case differs in some respects, however. For example, in the chronic non-tuberculous open empyema, the aim of the surgeon is to obliterate the cavity by methods that will produce a minimum expansion with a minimum mutilation, and a consequent increase in vital capacity, the amount of rib resection always depending on the power of the lung to expand. More-
Treatment of Empyema Thoracis

over, in tuberculous empyema, decortication is never done because no expansion is desired. Then, too, tuberculous cases are kept open longer, for heliotherapy and the obliteration of cavities by thoracoplasty; also, muscle implants are used more freely. These cases are never good surgical risks, and they are more susceptible to surgical trauma. Although the mortality in chronic and supra-chronic non-tuberculous empyema has decreased with improved technique until it is now less than nine per cent, the mortality in tuberculous empyema has steadily increased to eighteen and eight-tenths per cent for the reason that more chances are being taken than heretofore. Many are profoundly septic, mentally depressed, and depressed physically; many have cardiac and renal complications, and have already had radical operations without relief.

Before considering plastic closure, the closure of bronchial fistulae deserves consideration, as no cavity with a patent bronchial fistula should be closed. Forty per cent of the bronchial fistulae close spontaneously if the wound is laid open, and many others will close after cauterization, or after the application of a three per cent alcoholic solution of gentian violet. Closure of larger fistulae is diffi-
Treatment of Empyema Thoracis

cult inasmuch as mobilization of a part of a lobe or isolation of a bronchus, with a view to obliteration by suture, may result in a lung or brain abscess, or in relighting a quiescent tuberculous process and unnecessary surgical trauma. In the plastic closure, an implant with an attached pedicle is used; the muscle is implanted on a surface that has been superficially decorticated for its reception while the arm is held in the extreme vertical position. After several negative cultures, the skin and muscles are loosened and approximated, and held with sutures and adhesive tape. After three or four days, the sutures are removed because they are not well tolerated by the friable skin of tuberculous patients who have had mixed infections of long duration. During the convalescence, the wound is held by adhesive as long as is necessary.

Empyema thoracis is relatively common in children. The etiological agents in the case of empyema in the child are the same as those which obtain in the case of the adult. Empyema in children should never be treated by extensive open pneumothorax because, inasmuch as a child's mediastinum is less rigid, the operation is usually fatal, especially if performed early. Even with this edict, the high mortality in very young children stands unexplained. It is rare to see acute
Treatment of Empyema Thoracis

Empyema followed by chronic empyema in children. In treatment, Douglas recommends partial rib removal with sealed siphon drainage and no irrigation. The cavity will be obliterated in children more rapidly than in adults; so drainage should be discontinued sooner. There is a tendency to thoracic deformity or postural defects following empyema in the growing child. On this account, therefore, it is wise to employ physiotherapy, to use graduated exercises, and to keep the child in touch with an orthopedics man.

The progress in undrained empyema cases will depend on the infecting agent and the general resistance of the patient. Foster believes it fair to assume that death should never result from empyema thoracis per se; that chronic empyema should not occur in properly treated cases of acute suppurating pleurisy; and that the basis of the determination of a cure should be the disappearance of all signs of sepsis, a complete obliteration of the empyema cavity as well as a healed superficial wound, and a long-time follow-up.

There is more to be said in the future about the treatment of empyema. Such a variance of opinion, and such a diversification of results are certain to encourage further investigation, presumably of a beneficial order. When one
Treatment of Mpyemia Thoracis

realizes that one of the major strides has been made since the World War, one is forced to admit that further advances are more than potentialities; and, furthermore, when one sees the tremendous amount of labor being expended on the problem at hand, one is likewise forced into believing that the collocation and subsequent correlation of these advances is not far removed. As individual physicians, rather than rival specialists, we must all lend our concerted efforts toward solving this problem, and, further, to attack it from a different angle, namely that of prophylaxis.
Bibliography


