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Treatment of acute empyema thoracis

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INTRODUCTION

Although the treatment of most diseases at one time or another in the history of medicine, has ranged anywhere from the utterance of mystic words to the arcan powers of herbs, stones and metals, still empyema seems to have enjoyed a surgical niche from the earliest time known. As the necessity for the evacuation of pus in the chest has been recognized since the time of Hippocrates and through the centuries that followed there has been a constant repitition in the advocacy of different methods of procedure. However in spite of this repitition and variety of management, the mortality of acute empyema has been reduced from what has been said to have been ninety per cent to fifteen per cent in the past century.

HISTORY:

Recognized by the Egyptians as early as 1500 B.C., as is evidenced in Papyrus Ebers (1): "If thou findeth, in some part of the surface of a patients body, a tumor due to a collection of pus and dost observe that at one well defined spot it rises up into a noticeable prominence, of rounded form, thou shalt say to thyself: 'This is a collection of pus which is forming among the tissues, I will treat the disease with the knife.,'" was the fact that drainage was the essential treatment of an abscess. Whether empyema was recognized and treated thus is not mentioned.

The earliest record of an operation for empyema is that of Hippocrates (2) 460-370 B.C. He attributed the cause of empyema to the termination of pneumonia, realizing that most cases followed pneumonia, but he endeavored to contribute the fluid to a ruptured vessel. His procedure was to cut down on the third rib from the last, then make a perforation with a trochar so as to give vent to small portions of the fluid. The opening is then to be filled with lent and the remainder evacuated in twelve days.(2)(3). Cautery was frequently used in these cases. (4). On the tenth or twelth day when the lent was removed warm wine and oil were injected and when the discharge became clear and glairy he introduced into the opening a hollow tube. (5) Observations as to the prognosis made by

Hippocrates are still essentially correct: "When empyema is treated either by cautery or incision, if pure and white pus flowed from the wound the patient recovered, but if mixed with blood, slimy and fetid they die."(6)

The years following Hippocrates the knife and cautery were used rather extensively and then for years there seems to be no mention of any extensive surgery until the time of Galen. (7) His observation was that there must be a way provided for the pus to escape from the thorax, to avoid the varages especially pithisis, of which it might have been the cause. He resected carious ribs and injected warm wine into the cavity and instructed the patient to cough while leaning toward the affected side and if the pus did not thus escape it was removed by aspiration.

There was then very little progress made in the treatment of empyema up to 1810 when Aupepin (8) described a "New technic"for preforming a thoracotomy by making the incision in the skin and intercostal tissues at different levels, thus giving a valve like action to prevent pneumothorax following the withdrawal of the aspiration tube. This is the first hint that physiological processes were to be considered in the treatment of empyema. Paracentesis was common during the first half of the nineteenth century. (9) H. Row reported eight recoveries out of nine cases as early as 1844 drained soley by aspiration.(47) In 1860

Walter (10) took a further step forward and resected a sound rib in order to establish free drainage. Protain(11) established closed drainage and with a syphon system drained and irrigated the cavity. Hewett(12) advised continuous aspiration followed with closed drainage by introducing a catheter into the cavity by means of a trochar and cannula; then irrigating the cavity with potassium permanganate. Parker (40) in 1882 reported pus aspiration and air injection. This was also advocated by Potain(41) and Forlanine(42).

Von Eberts (13) advised "early diagnosis to prevent complications" and stressed the importance of the physiological as well as the pathological stand point in the management of empyema. The idea prior to Von Eberts was to conform the chest to the lung rather than the lung to the chest. He was the first to maintain that the treatment was to make the lung conform to the chest wall.

Lilienthal and War in 1914 (14) took up Von Eberts' idea and treated empyema with physiological and pathological considerations and reduced their total mortality to twenty eight per cent.

PHYSIOLOGY:

The average pre war mortality for empyema was fifty to seventy per cent in children and twenty to thirty per cent in adults. The war with thoracic injury and influenza complicated with empyema gave an impetus to the

study of the physiology of the thoracic cavity and management of its affections that measures were instituted which reduced the mortality to almost nothing in acute uncomplicated cases and Davis (35) states: "Death should not occur from acute empyema itself alone and that chronic empyema should not occur in properly treated acute cases."

This sudden change in the attitude toward the treatment of empyema is traceable to the experimental work of Graham and Bell in 1918. The study of physiology of the intrathoracic organs made its beginning in the seventeenth century by the work of Boyle, Mayow, Discorts and others(27). Hutchinson's paper on vital capacity in 1846 explained that decreased vital capacity was due to anything which interferred with respiratory movement of the thorax, either intrathoracic or intra-abdominal; inflamitory and infiltrative lesions affecting the pulmonary substance as pneumonia, tuberculosis, bronchiectasis and cancer; alterations of the elasticity of the pulmonary parenchyma, such as is produced by emphysema; and increased pressure in the pulmonary circulation. Physiologists continued and worked out the thoracic physiology, but the most important contribution of spirometry to surgery began in 1918 with the work of Graham and Bell whose classical study of open pneumothorax and its relations to the treatment of acute empyema was the stimulus required to alter the whole plan of procedure in the surgical treatment of pleural exudates. (27)

The vital capacity of a normal individual is

about thirty seven hundred cubic centimeters. (43) And the diameter of an opening for a pneumothorax that is tolerated is directly dependent on the vital capacity. Aufrecht realizing the importance of the diameter of the opening in pneumothorax stated, at the Eighth German Congress for Medicine 1903 (24) that the opening should not be of a greater diameter than the bronchus of that lung. However Graham and Bell mathematically formulated the maximum opening tolerated by a person with a vital capacity of 3700 cc. and found it to be 51.5 square cms. and varying in size directly with the vital capacity. An interesting finding by Lemon 1931 (27) is that the vital capacity of the colored race is 15% less than that of whites and the fore-going conclusions concerning vital capacity are confirmed by Ochsner Alton and Gage (21) when they observed that "Negros did not stand open drainage of empyemata as well as Whites, " and in their series of cases the total mortality was 15.3%, 10% mortality in whites and 25% in the negros.

Experiments during the world war by Graham and Bell showed apparently conclusively that patients with pneumonia or with a beginning empyema were very likely to be killed by the injudicious use of open drainage. The principle reason for death being altered pressure relationship of the open pneumothorax. (39)

The act of inspiration consists essentially of

an enlargement of the thorax with a resultant inrush of air down the trachea and into the lungs in order to equalize the pressure of the air outside the body and inside the lungs. The act of expiration, on the contrary, is accomplished by a diminution of the thorax, which in turn forces the air out of the lungs. The amount of air, therefore, which is taken in and given out with each act of respiration, under normal conditions is regulated almost entirely by the extent to which the thorax enlarges itself. Normally the lungs actually fill the pleural cavities except for a small amount of fluid which serves to moisten the two pleural surfaces. The elasticity of the lungs tends constantly to pull them away from the chest wall; the cohesive forces between the parietal and visceral layers of the pleura tend to hold the lungs in apposition to the chest wall. The result of the opposite directions in which these two forces are working creates a tension in the pleural space which is less than atmospheric pressure or a negative pressure of seven millimeters to ten millimeters of mercury. (50)

The Empyema Commission of the United States Army (28)(50) preformed the followong experiment: If air is injected into one pleural cavity of a freah human cadaver with out adhesions; until a pressure of ten millimeters of water is obtained the pressure in the opposite pleural cavity will register nearly the same. This experiment shows that even with comparatively slight alterations of pressure the mediastinum is crowded over against the opposite

lung. Experiments on living dogs, by creating an open pneumothorax on one side, gave characteristic responses which are manifest not only by a change of intrpleural pressure on the opened side but also by a change of the same kind and of practically the same degree on the unopened side. Upon closure of the opening there was an immediate simultaneous response in both pleural cavities with a complete restoration of negative pressure. (50) The extreme mobility of the human mediastinum in the absence of adhesions has been shown in x-ray studies on pneumothorax by Strivelman and Rosenblatt (48). J,B.Murphy (49) recognizing the dangerous tendency of the mediastinum to "flutter" in an open pneumothorax, recommended traction on the lung in an attempt to immobilize the mediastinum.

METHODS OF PROCEDURE:

To analyze methods of treatment properly in a disease so protean, every case should be considered in relation to the following factors: (17)

(1) the acute mechanical condition of the abscess and the surrounding structures. In no other surgical condition are these so complex, variable and important.

(2) the time relation of the formation of the abscess to the original pneumonia. This is perhaps the most important single factor in prognosis.

(3) The age of the patient. This is extremely important due to the greater liability of infants to the syn-

pneumonia.

(4) type of infecting organism. Streptococcal infections incline to the syn-pneumonic form more than the pneumococcic form and are to that extent more deadly.

(5) complications such as pericarditis and mediastinitis.

(6) intercurrent diseases.

(7) length of time the empyema has been present before treatment was started.

(8) the results at least a year after cessation of treatment checked by X-ray.

The body has three ways of dealing with a collection of pus first by absorbing it, second by organizing it and third by evacuating it with a subsequent growing together of the walls that have contained it. In empyema the first is of little value, the pleura having limited absorbing powers especially when compared to the peritoneum. The second is a hinderence rather than a help in empyema. The third method is in empyema as in all abscesses the best. In some regions of the body where abscess walls are merely displaced soft tissue obliteration of the cavity is automatic upon evacuation of the pus. In others where the walls are rigid as in the skull it is a matter of utmost difficulty. In empyema the problem is midway between. The chest wall being rigid and the part of the wall formed by the lung varies widely both in its stiffness and readiness to join the other. (17)

The most important factor in the cure of an empyema is the reaction of the body by which two granulating surfaces, develope at any point of contact a powerful and persistant tendency to grow together over their whole extent. This is because at the meeting point the granulations fuse and the fused mass, in changing into its final form of scar tissue contracts, so pulling together the granulations. Brown (17) states: "I do not think an empyema is ever cured except by the complete growing together of the two layers of the pleura. The pleural space may possibly reform in parts owing to the proliferation of the surviving endothelium."

Empyema has been considered more or less a surgical emergency in the past, operations being preformed as soon as the diagnosis was made. But since the World War, again referring to the work of Graham and Bell the procedure has changed. Muller (24) quotes the Empyema Commission: "The evacuation of the pleural exudates by operation early in the disease involves greater risk without compensating benefits." F.E.Fowler (30) in discussing acute empyema remarks: "Stop, look and listen before instituting radical treatment."

The treatment of empyema from the onset till surgery is instituted is medical (as is the post-operative management which is to be considered later).
The pre-operative treatment is essensially the same as is the treatment for any acute infection. The patient should

be given the benefits of complete rest, which is the accepted management for any acute infection. Diet is also of great importance in combatting infection. The high carbohydrate diet is nearly universily accepted. 3300 to 3500 calories should be given daily to an average individual. (20). The one phenomenon which should be used to regulate the diet is the nitrogen balance. It should be checked frequently and a negative nitrogen balance avoided. Fluids are forced and blood transfusions if necessary. (37) Arthur McCormack discussing the report by Clark Baily (36) advocated the use of bacteriophage therapy and states that no open operation is necessary with such medication. In cases where there is an inadequate response by the hemopoitic system, in the way of a leukocytosis, foreign protein intramuscularly or whole blood in a similar manner may be indicated.

Simple aspiration of exudate with a needle and syringe is a medical procedure and can be instituted at any time without danger if carefully carried out. The procedure is to introduce a large needle through the intercostal space into the pleural cavity. Bloch and Parrish (34) describing aspiration give the following procedure: Press the thumb on the rib above the interspace chosen, thus protecting the intercostal artery, vein and nerve. The needle being inserted through the intercostal space beneath the thumb. Aspiration should be carried out before any type of surgery is attempted because it confirms the diagnosis, gives the consistancy of the pus, gives the type of organism

involved, leads to the proper localization of the pus and in cases of large exudates reduces the pressure. (36)

Bloch and Parrish (34) following Elias (44) and Danna (45) have revived the aspiration of the pus with injection of air into the cavity and report especially good results in children. The procedure is to aspirate 30 to 50 cc of pus and inject and equal amount of air. This is repeated until no pus can be aspirated. The injection of an additional ten or fifteen cubic centimeters of air will facilitate the aspiration of any remaining pus. These tappings are repeated every four to seven days.

The air replacement has several definite purposes: First the pleural cavity can be completely emptied by air replacement and Bloch and Parrish checked with the X-ray to frequently find the cavity completely evacuated by this procedure. They also proved that only fifty percent of the fluid can be evacuated by the simple aspiration. This is verified by Davis.(46) Second the air is slowly absorbed and the negative pressure is gradually restored in the intrapleural cavity exerting a steady traction force on the lung and permitting gradual re-expansion of the lung with eventual pleural contact. Third the air creates a positive pressure. This produces immobilization and compression of the lung with elimination of pulmonary tension and therefore rest and healing. Fourth the air prevent rapid changes in the intrapleural pressure with their sequelae of edema of the lungs, pain, cough and cardiac changes. Fifth the air

keeps the viseral and parietal pleura separated until the inflamation subsides, thus adhesions do not occur or are slight. Sixth the natural mechanism of defense in exudative pleurisy is the separation of the pleura and compression of the lung. Air replacement maintains this mechanism. Seventh this procedure may shorten the term of illness by preventing the exit of infected material from the compressed lung.

Bloch and Parrish made several interesting observations.(34) In cases where there was thick pus on the first tap there was thin pus that flowed easily by the second tap. Also that high fevers subsided after the first tap and the general condition usually was much better after the first tap. These men have treated fourteen consecative cases by this method exclusively. Only one dying and this child having complications of otitis media and acute gastro-intestinal failure. The ages of these cases were from six months to nine years.

In referring to aspiration therapy Eggers (33) states: "This procedure may cure, but do not attempt to cure by it."

Again quoting Eggers (33): "The dangers of continued aspiration are; septic absorption and infection carried into the chest wall by the needle with a resulting cellutitis."

There is more danger connected with an aspiration of the chest of a new born than of an adult and Grulee

and Bonar (29) recommend the safest point as being at the sixth interspace at the angle of the scapula.

SURGICAL:

There are two main divisions of the surgical procedures in empyema, the "closed" and the "open" methods. The closed method is draining or attempting to drain the exudate without allowing the atmospheric pressure to enter the pleural cavity and produce a pneumothorax. The open method is drainage of the cavity by an open operation producing a pneumothorax, not attempting to prevent the collapse of the lung.

The closed method is more of a minor procedure and will be considered first. The method to be described is that advocated by Eggers (33) (other closed methods are essentially the same with variations in technic). Eggers states that the closed drainage is more physiological than the open drainage because it maintains the negative pressure within the empyema cavity and thereby least disturbs respiration. It is to be used in early septic cases in chich early in the pneumonia the presence of fluid itself is a menance to the patient, extensive exudates, bilateral empyema, and pyopneumothorax. The procedure is merely to block the area, either the eighth or the nineth interspace in the posterior axillary line, with local anesthesia and insert a trochar. Remove the obturator and replace a catheter through the trochar and remove the trochar, keeping the catheter clamped.

A rubber cuff is put around the catheter and pinned. A small piece of gauze is put under the pin and adhesive tape is applied to prevent slipping. Large exudates are evacuated slowly, about two hundred and fifty cubic centimeters at intervals of several hours. After all of the pus is out it is made continuous drainage. The catheter is connected with rubber tubing the end of which is kept emerged in water to keep the condition "closed".

The ease of preformance, the minimum disturbance it causes the patient, the facility of irrigating the cavity and avoidance of large pus soaked dressings commend the method.

Contra- arguments are:

(1) Inadequate drainage.

(2) Inability to expose large fibrinous clots.

(3) Blocking of the tube with retention and re-infection.

(4) Much attention is needed to insure flow.

Irrigation of the cavity is urged by some and not used by others. Eggers (33) uses a simple syphon irrigation system to increase drainage. Some of the solutions used for irrigation are physiological saline solution, potassium permanganate, carbolic acid (1-60) and especially Dakin's solution which was recommended by the Empyema Commission in 1918. There have been many complicated irrigating systems described and advocated. The system of syphoning bottles arranged by Overholt (31) is typical of them all.

The use of an oval trochar in the establishment of closed drainage has been suggested by Sarnoff (23). He maintains that the oval form will allow a larger trochar to be passed between the ribs and that consequentally a larger catheter can be employed with the resulting better drainage in cases where the intercostal spaces are smaller.

OPEN METHODS:

The simplest form of open operation for empyema is the thoracotomy and drainage. The procedure is to make an incision several inches in length in a dependent intercostal space parallel to the ribs. Usually the eighth or nineth interspace in the posterior axillary line is a satisfactory site for incision. Anesthesia employed is either local infiltration or if necessary a general anesthesia. The local block is much more preferable, for with the impaired pulmonary parenchyma, which is usually the case, inhalation anesthesia is contra-indicated. The pleura is exposed and after all bleeding is controled the pleura is opened and drainage tubes inserted into the cavity and the skin sutured around the tubes. This procedure is advocated by Glazer and Epstine (22) and in their publication state:. "In the four cases of empyema of the new born, diagnosed during life two infants treated by intercostal incision and drainage recovered and two treated by miltiple puncture of the pleural cavity died. It therefore seems that the inter-

costal incision and drainage is the method of choice at least in the treatment of empyema of the new born." Shaw and La Fetra (15) also advocate this procedure in children.

Rib resection:

It seems as though the most widely used form of pleural exudate drainage is rib resection. The incision is made similar to that of a thoracotomy, but over a rib rather than in the intercostal space. The rib is exposed and a portion of the rib resected subperiosteally. The intercostal vessels and nerves being carefully preserved. The open ends of the rib are then covered with bone paste. The pleura is opened after hemastasis is adequate, and rubber tube drains inserted into the cavity and the skin sutured.(54)

There are a good many modifications and additions to this procedure:

Beck(51) has advocated the packing of the empyema cavity with the antiseptic bismuth paste which bears his name. Reports as to the use and results of this maneuver are very limited.

J.F.Connors(20) and C. A.Roeder(19) have published good results from packing the empyema cavity with gauze. Roeder(19) maintains that the advantages of gauze packing are: first it holds the lung steady following the operation, which is most comforting to the patient, second it clears the exudate rapidly from the walls of the cavity, third it breaks up numerous small abscesses in the periphery of the lung which are usually present, fourth it eradicates ex-

ternal purulent drainage almost completely after forty eight hours, and fifth it brings about obliteration of the cavity at least as rapidily as any other method. However the gauze must be changed daily and anesthesia is needed for the first change. Dr. Roeder used the packing only in cases where the lung was not permanently compressed by an organized thickened pleura and intra-pulmonary scar tissue.

In the cases reported by Connors(37) he removed the pack for the first time at the end of forty eight hours and in a fair majority did not replace it.

C.M.Van Allen(38) has devised a tube for open drainage. The tube is constructed of pure live gum rubber. It consists of two separate parts which telescope into each other and each has a large flange at one end. Rib resection is preformed in the usual manner and the smaller or inner tube is put into place and outer tube fits snuggly over it. The two tubes are sutured together and thus the inner tube has the flange against the parietal pleura and the outer tube has its flange against the skin. This devise gives permanent drainage until the tubes are taken out.

F.J.Hathaway(18) has described a procedure of immediate closure of the incision with no permanent drain in the pneumococcal type of empyema. His procedure is to open the pleural cavity and swab it out clean with dry swabs and close tightly immediately. He maintains that air is more quickly absorbed than fluid and the lungs expand more rapidly and more easily. The pus has to be

aspirated from time to time after the surgical procedure.

The flap operation is again brought into the leterature by Nicoll(52). It also is a modification of the rib resection. The technic as described by Nicoll(52) is as follows: "After selecting the sight of operation make a U shaped incision with the point where the rib is to be resected as the center of the base of the flap thus made. The skin and subcutaneous tissue make up the flap. The portion of the rib to be removed is exposed and removed." Dr. Nicoll uses a special type of button to keep the drainage open and a piece of rubber dam is used to connect the drainage opening and the lower part of the flap. The vertical part of the incision is sutured. The demensions of the flap should be about four inches by four inches.

Reasons given by Nicoll(52) why this is the best treatment are:

First it is physiological, because it takes into consideration the normal condition of negative pressure within the pleural cavity and respects it. Second it is a closed method of drainage and remains so from the beginning to the end. Third there is always adequate drainage because of the generous opening into the pleural cavity. Fourth it permits early operation in empyema before adhesions alter the position of the lung, without the dangers resulting from mediastinal flutter and collapse of compressed lung. Fifth it can be done under local anesthesia. Sixth it is a closed method so it can

be used either in children or adults. And seventh it shortens convalescence.

POST-OPERATIVE MANAGEMENT:

The treatment of empyema after surgery has been instituted is somewhat dependent on the type of procedure employed. The main objectives are drainage and obliteration of the cavity by expansion of the lung. The patient should be placed in a semi-recumbent position lying on the affected side to facilitate drainage, and the infection combatted in the same manner as was discussed in the pre-operative management. After the patient has reacted to the operation and regained some strength pulmonary gymnastics should be indulged in to aid in expansion of the lung. Some of the exercises in practice are coughing, blowing bubbles, ballons or Wolf bottles, all sorts of breathing exercises.(33) The problem of irrigation has been briefly touched upon and will not be discussed again A mistake often made is allowing the drainage tube to remain for to long a time, so that a sinus is kept open which would otherwise close. The post operative period in empyema is occasionally two to three weeks, but usually is two to three months or longer. (16)

GENERAL CONSIDERATIONS:

It has been rather generally conceded that acute empyema is rarely so urgent as to require treatment other

than aspiration before a fairly comprehensive study of the condition can be made. Such a study should include the attempt to determine the nature of the respiratory infection, the type and extent of the pneumonia that complicates it, the time of appearance of the empyema with respect to the onset of the disease, the type of infecting organism concerned in the empyema, and the coincident presence of conditions other than empyema including unilateral or bilateral pneumonia, peritonitis, meningitis, lung abscess, and septicemia. The determination of all of these things is obviously not easy and sometimes quite impossible, particularly in infants and young children, but usually sufficient information may be obtained to divide the cases into two large groups. The post-pneumonic pneumococcic empyemas and the post-influenzal streptococcic empyema. Each group may again be capable of subdividion into two; the simple empyemas and the empyemas associated with other serious pathological conditions. (53)

In the treatment of simple acute empyema there is the choice of the three methods of procedure and their modifications as described. Each of these methods have their advantages and disadvantages and no one method is generally accepted. However there are certain rather generally accepted dictums to be followed. The first is that aspiration should always be done, before any other procedure is carried out, to confirm the diagnosis if for no

other reason. And it is also generally accepted that the large exudates with great intra-thoracic pressure should be drained by a closed method or aspiration until the pressure is relieved. (30) This is the typical streptococcic type and frequently they occur while there is still active pneumonia with the resulting low vital (25) capacity and this is more reason for the conservative treatment. After the pressure is relieved and the vital capacity normal or nearly normal the most logical method of procedure is debatable and undoubtedly varies with the individual. (26)

Fowler(30) follows this same train of thought: "Determine as accurately as possible the physical condition of the patient, ascertain what has gone before in the way of pulmonary infection and try to gauge what surgical procedure can best be withstood by the patient." However he continues: "Don't conflict open and closed drainage, but use them together as is indicated."

Still another factor to be considered is the age of the patient and statistics show (53) (39) that the very young and the aged have the highest mortalities in acute empyema, and the choice of procedure should be more carefully considered and planned for patients of extreme ages(24)

If open drainage is considered to be the therapy of choice there are several factors to be considered. The important decision to be made is when to start the drainage.

This should not be started as long as there is any pneumonia left, because as has been shown the vital capacity is decreased, and a septic fever usually indicates that the pneumonia is over (32) and the exudate must be purulent. This usually means that the process has gone on long enough to have the mediastinum fixed with adhesions. A good rule to follow is that there be fifty per cent sediment of pus in the aspirated fluid before open drainage be instituted.(33) Besides doing an open operation to soon after the onset of the disease it is also possible to permit the condition to remain untreated over to long a period of time and the condition become chronic and respond very poorly to surgery (33)

The management of simple uncomplicated empyema is rather encouraging as the rule. But therapy in empyema complicated with some of the other pathological conditions mentioned is indeed discouraging. Heuer(53) finds pericarditis and septicemia have especially unfavorable prognosis as shown in Figure I.

Harrington(26) reports four deaths from seventy five cases of surgically treated empyemas. And these four deaths were due to: first case, meningitis myocarditis and broncho-pneumonia; second case mitral endocarditis and bilateral broncho-pneumonia; third case fibrinous pericarditis and mediastinitis and the fourth case acute serofibrinous hemorrhagic pericarditis.

The six case histories to be included in this paper will be the six deaths that occurred in Muller's series of ninety nine cases of empyema treated by the various surgical methods and they also show that it is other pathological conditions than empyema that cause the deaths.

CASE I. Female age 69 years. No satisfactory history could be obtained. Was seen by a physician who immediately sent her to the University Hospital (Jan. 11, 1920). The patient was unkempt, dirty and had bed sores from incontinence. She was quite toxic. The leukocytosis was 12,200. The left chest appeared solid with fluid, and aspiration, withdrew six hundred cubic centimeters of turbid fluid containing staphylococcus aureus. On the following day under local anesthesthesia a tube was pushed into the thorax between the sixth and seventh ribs and thereafter good drainage by Kenyon method was affected. The urine output was low and the patient slowly declined into stuper until death occurred on the fourth day after admission.

CASE II. Male aged 35 years, had empyema on admission to the University Hospital (2-15-1920) from a pneumonia which began eleven days previously. Aspiration (250 cc.) revealed pus containing pneumococci. The leukocytes numbered 36,500. On the following day under local anesthesia two rubber tubes were introduced through an interrib puncture. Drainage seemed satisfactory and irrigations with carbolic acid (1-60) were given. His general condition remained poor and signs of pericarditis and peritonitis appeared. He became more toxic and died ten days after operation. At autopsy the pleural cavity was found perfectly drained, the pericardium and peritoneum showing evidence of infection.

CASE III. Male aged 36 years. Following a streptococcic pneumonia, empyema developed and the patient was transfered from medical service 2-24-21. Under local anesthesia two rubber tubes were introduced through an interrib puncture. Much thick yellow pus was present. Drainage seemed satisfactory, but the patient remained ill. On March 3, a blood culture heavily positive for hemolytic streptococcus. On March 3rd, thirty cc. of 1% mercurochrome given intravenously followed by a chill. On the following day the fever was less, but again blood culture revealed heavy load of hemolytic streptococcus. On March 8, mercurochrome repeated without reaction. Died two days later.

CASE IV. Male aged 28 months. Five weeks previously child developed pneumonia. Later had chills and sweats. X-ray showed fluid in left chest. Admitted 8-9-23. Aspiration below the rib posterior yielded pus at the depth of 4 cms. containing hemolytic streptococci. Rib resection done under nitrous oxide. Two rubber tubes inserted, open method. On 8-23 was worse again. X-ray showed lesion in upper lobe probably pneumonia. Died 14 days after the operation.

CASE V. Female age 13 months. Ten days previous to admission 1-13-24 patient developed pneumonia. Crisis on 9th day followed by rise in temperature and prostration. On admission had dyspnea, cyanosis and a completely flat right chest. Abdomen distended. Temperature 103.4, pulse 160. Under local anesthesia a small rubber tube was introduced into the pleural cavity by an interrib puncture. About 500 cc. of pus were evacuated and the tube clamped. Following operation the temperature rose to 108, the pulse became rapid and feeble and death occurred six hours after the operation.

CASE VI. Male aged 55years. On 6-25-24 had a chill, pain in the chest and frictions. Admitted to medical service as a case of pneumonia. Fluid diagnosed 7-3. Aspiration revealed thin fluid smelling like bacillus coli, but smears revealed streptococci. On this day under gas anesthesia an interrib puncture was done and drainage established. The tube was opened for ten minutes in every hour during the first six hours. Respiratory rate very high. On 7-8 he was still toxic with fever, sweats, cyanosis and under gas anesthesia a rib resection was done and considerable pus evacuated and the cavity drained. But little improvement was manifect and as the x-ray showed incomplete drainage, the cavity was explored on 7-15 under local anesthesia. A pus pocket containing one hundred cc. of pus was found and drained. He died the following day 7-17-24.

It was thought that perhaps an idea as to the mortality rates of the various procedures and combinations of procedures might throw some light on the procedure of choice, but it was found by Muller(24), Heuer(53) and others that different procedures carried out by different men gave different results and also that a variety of results were found for different years with the same type of management.

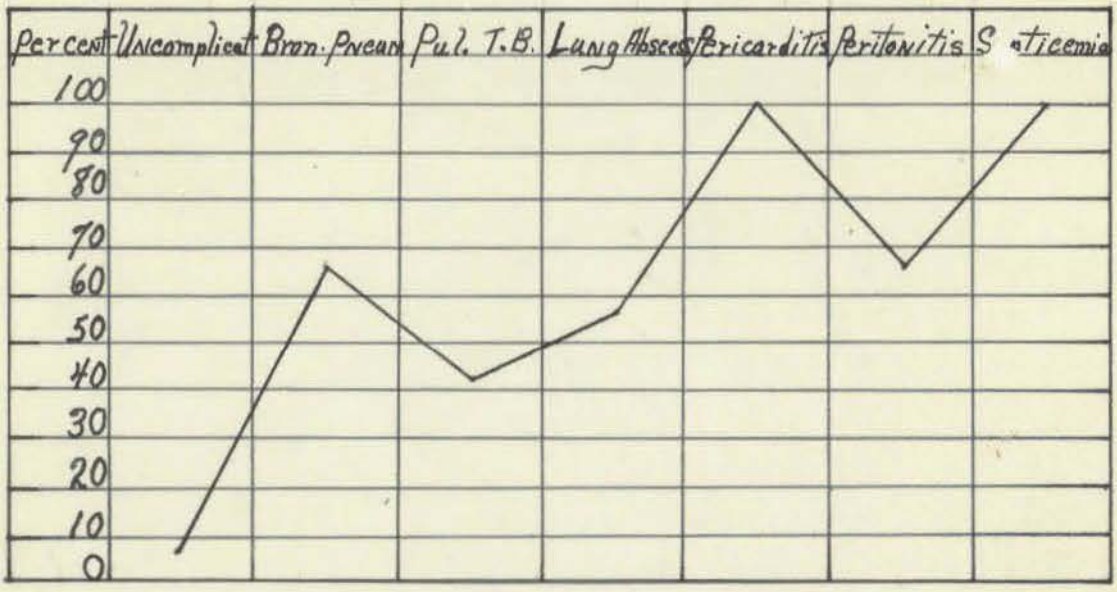

Fig. 1.

Mortality according to various pathological conditions associated with empyema. (Heur's Baltimore series).

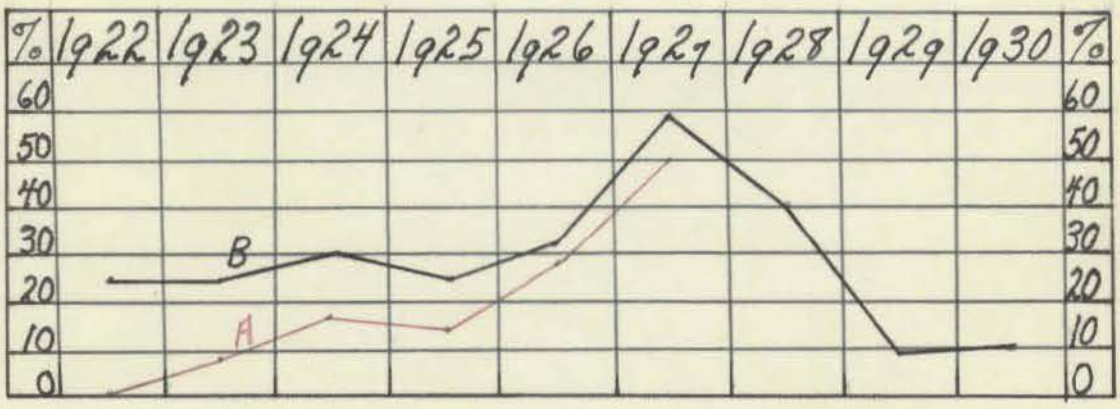

Fig. 7.

"B" is the mortality rate in pneumonia by year periods.

"A" is the mortality rate of empyema by year periods.
(Heuer)

Quoting Heuer(53): "It has been of interest to analyze not only the mortality in empyema, but the mortality in the pneumonias occurring at the same time. In a series of 1200 cases the mortality from pneumonia in the wards of the Cincinati General Hospital was 25% in 1922 and 1923; 30% in 1924; 25% in 1925; 31% in 1926 and 50% in 1927, and a graph of the mortality percentages in pneumonia and empyema show the curves nearly parallel each other Fig. #7, and it seems from our experience that a virulent type of pneumonia with a high mortality whether of the pneumococcic or streptococcic type will be associated with or followed by empyema complicated by other serious conditions and with a high mortality." Graham and Berck(39) have similar curves Fig. #2.

The type of organism may not be considered as having any particular influence on the choice of treatment, other than the time of operation, but it has a great deal to do with the complications and mortality as is shown by Muller(24) and Heuer(53) in Fig. #3.

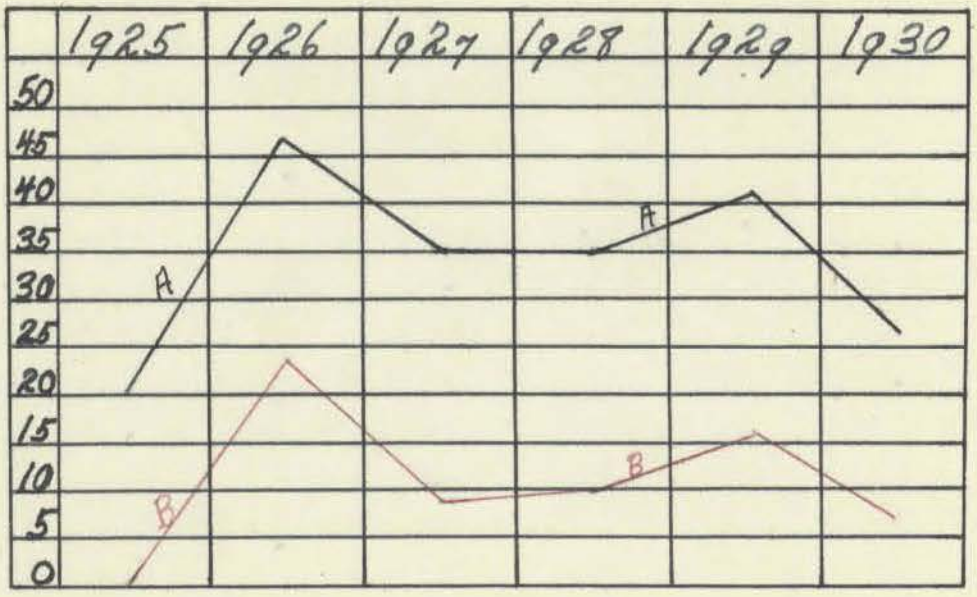

Fig. 2.

"A" is the mortality curve in 635 cases of pneumonia without empyema.

"B" is the mortality curve of 166 cases of pneumonia that developed empyema.

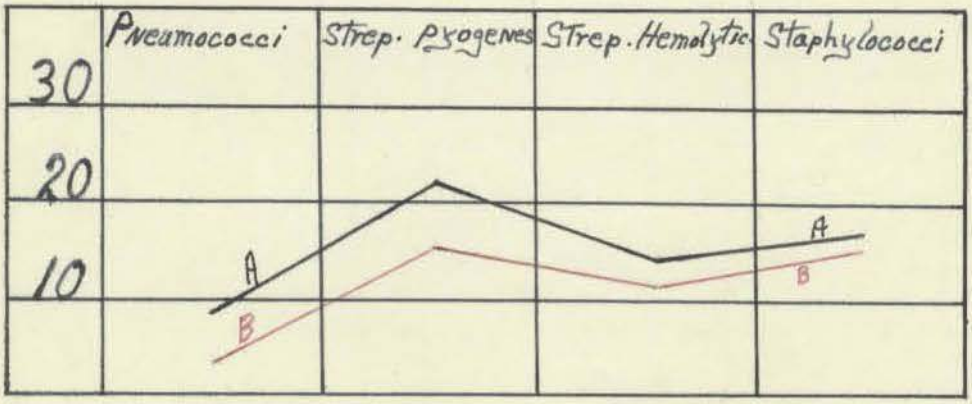

Fig. 3

"A" is the mortality in empyema as to type of organism.(Heuer)

"B" is the mortality in empyema as to type of organism.(Muller)

SUMMARY:

The factors that prompted this study in the treatment of empyema are: first that empyema is not an infrequent malady, second that there are several rather different methods of procedure in the management of empyema and I was anxious to know which of these was to be considered the most logical and why, and third that the mortality and morbidity of empyema are still rather high.

In an endeavor to explain these factors I briefly reviewed the history of the various methods of empyema therapy from the time of Hippocrates to the World War, considered the physiology implicated in empyema and its relation to the management of the disease, discussed the methods of procedure and general considerations as found in the leading periodicals and arrived at the following conclusions:

(1) That there is no ideal treatment for empyema which is evidenced by the multiplicity of procedures in practice.

(2) That there are two physiological considerations that must be respected in the treatment of empyema; the "vital capacity" and "mediastinal instability".

(3) Provided that drainage is adequate and timely the type of treatment has little affect on the mortality.

(4) That it is not empyema alone that is fatal, but secondary pathological conditions that complicate

the empyema.

(6) That in the final analysis the prognosis in acute empyema is dependent on the virulence and type of organism causing the infection.

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