EARLY PULMONARY DECORTICATION IN THE TREATMENT OF POSTTRAUMATIC EMPYEMA

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OF ALL THE TRAGIC SEQUELAE OF WAR, few are more distressing than the problems of those whose injuries result in chronic intrapleural sepsis. These unfortunates are inevitably found in large numbers through the post-bellum years either doggedly submitting to one major operative procedure after another, or resignedly suppurating through a shortened life-span of chronic invalidism.

Surgeons interested in thoracic disease have long been mindful of the magnitude of the problem of chronic empyema and have been prodigious in their efforts toward its solution. Despite many notable contributions elucidating many of the factors concerned in the inception of chronic empyema, it still occurs all too frequently following injury to the thorax. An examination of the voluminous literature on the subject brings out the striking fact that empyema is thought of and written about, for the most part, as though all empyemas were of the same generic type. Posttraumatic empyema certainly gives rise to a far higher incidence of chronicity than does meta- or post-pneumonic empyema. Yet little effort is made in the literature to establish vital, fundamental differences. The inference is too often left that empyema thoracis is empyema thoracis, regardless of its mode of origin. Yet significant differences do exist and must be recognized if we are to approach properly the posttraumatic empyema problem. That this difference was not more clearly recognized and emphasized by those who studied the large number of empyemas during World War I is remarkable. Perhaps the correct explanation is Churchill's[1] suggestion that the influenzal empyemas so overshadowed the posttraumatic cases in numbers and in interest that the individuality of the latter group was not recognized.

Despite modern surgical therapy and various chemotherapeutic adjuncts it now seems clear that no less than 15-20 per cent of those receiving penetrating and perforating thoracic wounds in this war will develop posttraumatic empyema[2]. When one contemplates the global scale of this conflict, and the probable total number of casualties, one becomes aware of the unprecedented chronic empyema potential that exists. The value of any method of treatment that will minimize the occurrence of chronic, crippling intrapleural infection following wounds of the chest is readily apparent.

This paper is a presentation of what we believe to be the most rational

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and effective method of treating posttraumatic empyema and represents the most productive approach, we believe, toward the prevention of the chronic phase of that disease. We are aware that much of this represents a radical departure from time-honored concepts.

In any study of posttraumatic empyema one is struck by the importance of the presence of blood in the pleural cavity as the antecedent factor. Much of the knowledge that we have gained pertaining to posttraumatic empyema has stemmed directly from a study of the problem of hemothorax. The vast majority of posttraumatic empyemas are infected hemothoraces, and the present rationale of treatment represents the direct application of those principles learned in dealing with hemothoraces both clotted and unclotted. Since

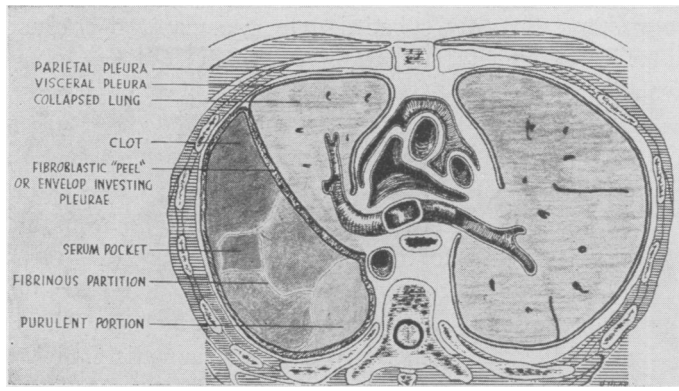

FIG. 1.—Photograph of diagram of cross-section of chest, with an infected organizing hemothorax of the left side.

the vast majority of posttraumatic empyemas develop on a basis of an hemothorax, the nature of the empyema can best be understood by an inquiry into the pathology of that entity. Studies of the intrapleural changes in hemothorax have been remarkable chiefly by their absence. The thoracoscopic examination of the pleura in cases of hemothorax by Edwards and Davies[3], in 1940, represents one of the first serious efforts to ascertain the nature of the pleural response to blood in the pleural cavity.

The opportunity to operate upon and decorticate the lung of a case of clotted, organizing hemothorax, by one of us (T. H. B.) during the African Campaign, led to a recognition of the essential pathology of hemothorax and to a study of a large group of similar cases. This experience has yielded much valuable and applicable information.

As has been pointed out in a recent paper by Samson, Burford, Brewer and Burbank[4] all hemothoraces are associated with very typical and definite changes within the pleural cavity of greater or lesser degree. The essential feature is the formation of a fibroblastic membrane or "peel" over the visceral and parietal pleurae. This membrane forms a sac or envelope within which the hemothorax is contained. The relationship of this hemothoracic envelope to the visceral and parietal pleurae can be readily visualized by consulting

Figure 1. This membrane forms from the deposition of fibrin on the pleural surfaces. Red blood cells are caught in the fibrin meshes and a definite "peel" very early takes form. This layer begins to undergo rapid active fibroplasia and angioplasia, and one can soon recognize an "older" side toward the pleura and a "younger" side toward the hemothorax. From the pleural side of the fibroblastic membrane, fibroblasts wander out toward the younger portion and nests of angioblasts rapidly give rise to capillaries. The transition to adult fibrous tissue is prompt, and by three weeks the cellular pattern of the "peel" is well defined. Figure 2 shows the cellular pattern of a three

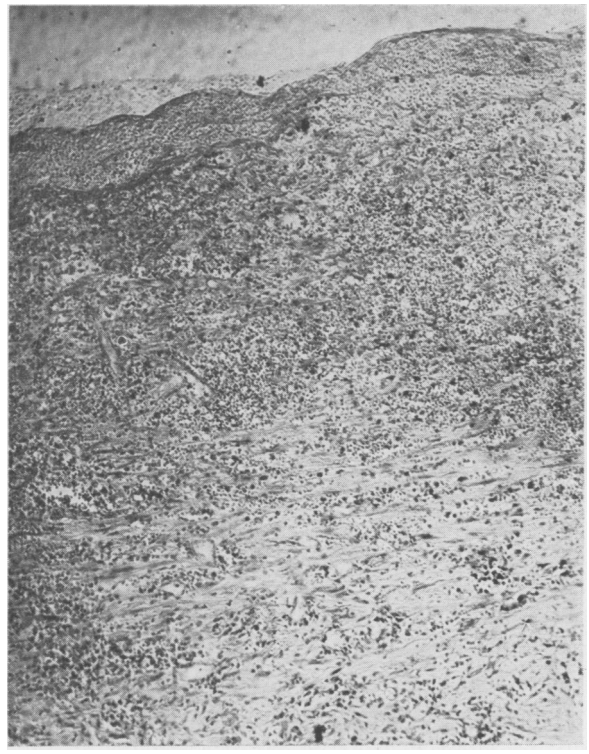

FIG. 2.—Photomicrograph of fibroblastic membrane of three weeks duration. Note active fibroplasia proceeding from pleural surface of "peel," which is at bottom of figure toward the "younger" portion at top of figure. (× 100)

week "peel," and shows the fibroblastic nature of the membrane. As the process grows older the cellular intimacy between membrane and pleura becomes greater until by eight or nine weeks the majority of cases will present definite symphysis. Until this time the pleura remains remarkably normal, and a cleavage plane between "peel" and pleura is easily established. Forming in the presence of a collapsed or partially collapsed lung, this membrane maintains the collapse of the lung and forms the chief deterrent to its reëxpansion. Figure 3 is a photograph of portion of a typical fibroblastic membrane removed from a case of posttraumatic empyema.

Hemothorax represents the largest hematoma with which the body has to deal. It is for the most part far too large to vascularize rapidly, and this fact may very well play a rôle in its tendency toward infection. This is particularly true of a clotted one which cannot be aspirated. In a liquid hemothorax prompt aspiration with pulmonary reëxpansion results in a cessation and a resolution of the changes described. If infection supervenes in either the liquid or the clotted hemothorax the resulting empyema will be unique in two respects. First, the lung is collapsed and compressed to a greater or lesser

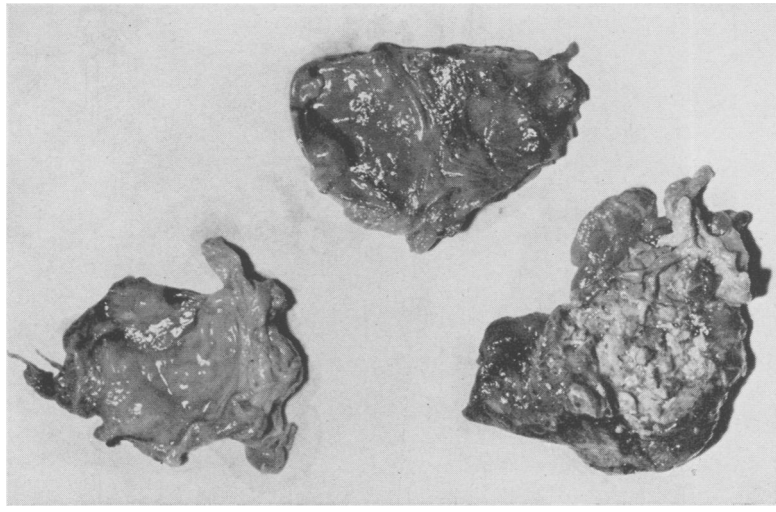

FIG. 3.—Photograph showing gross appearance of three-week-old fibroblastic membrane, or "peel," removed from visceral pleura of a case of empyema supervening upon an organizing hemothorax.

degree by the intrapleural blood even before infection occurs. Second, there rapidly develops, as described above, a constrictive pulmonary investment which restrains pulmonary reëxpansion. The recognition of these two factors is of prime importance in formulating a rational effective therapeutic approach to the problem of the empyema of trauma. Such a concept embodies not only evacuation of the pleural contents but also pleural divestment which will result in immediate and total primary pulmonary reëxpansion and complete obliteration of all pleural "dead space."

Fowler,[5] in 1893, and Delorme,[6] independently, in 1894, were the first seriously to attempt pulmonary mobilization in chronic empyema, by decortication. That the operation was so rarely successful was due to the fact that it was not attempted until late in the disease when, as we have seen from the discussion above, a complete fusion existed between pleura and the fibroblastic membrane. That the original attempts to perform decortication were made only upon patients who had been infected for many weeks, and often months, is understandable. To operate in the presence of pus without the advantages of bacteriostasis would have been inadvisable. These workers

were forced to adequately drain the empyema and await partial cavity sterilization. The idea of operating upon the acute phase of empyema was not to be considered in that time. Hedblom's[7] series of 30 cases, with 20 cures and one operative death, was the best reported but was not equaled by others. Decortication, except for the isolated instance, fell into disrepute and procedures designed to collapse the chest wall in upon the lung and thus obliterate the empyema cavity were devised. These procedures were admittedly serious compromises with the ideal and in no sense were restorative of function.

The operations of Schede,[8] Estlander,[9] the discussion procedure of Ransohoff,[10] and various combinations of these with partial decortications, such as the operation of Keller,[11] became the accepted operative approach to chronic empyema. The operative mortality remained high and the road to a cure for the patient remained a long hard one.

Samson and Burford (*loc. cit.*) in the course of a rather extensive experience in the decortication of large organizing hemothoraces were able to study a group of 15 early posttraumatic empyemas treated by decortication. Part of these were found to be infected at operation, when locules of pus were found within the hemothoracic cavity (see Figure 1) and when the case had been submitted to operation in the belief that a noninfected organizing hemothorax was being dealt with. A few were purposely operated upon immediately after obtaining positive smears or positive cultures upon examination of the fluid obtained by thoracentesis. The remainder were known massive empyemas submitted to decortication after preliminary rib resection drainage with attempts to sterilize the cavity. No case of known, frankly purulent, posttraumatic empyema was submitted to primary thoracotomy with decortication. The results in this group were encouraging. Of the 15, five obtained a prompt cure, five were markedly improved but retained rather small basal empyemas, and in the remaining five, large empyemas persisted but the cavity was smaller than the original process.

The advent of penicillin into this Theater and the contributions of Lyons,[12] which have so significantly influenced the handling of wound sepsis in general, stimulated the present study.

Penicillin, with its known property of bacteriostasis and, thus, of diminishing the danger of invasive infection when operating in the presence of acute infection, seemed to us to be the awaited, necessary adjunct to render safe the early application of more effective methods to the therapy of pleural sepsis. The pursuance of a rational plan of treatment in posttraumatic empyema directed toward achieving early pleuropulmonary lysis, total ablation of infected tissue, complete primary pulmonary reëxpansion, with absolute obliteration of residual pleural "dead-space" relatively free from the danger of septic dissemination, at last seemed safe and applicable.

DESCRIPTION OF CLINICAL MATERIAL

In March, 1944, we began subjecting all suitable cases of posttraumatic

empyema to thoracotomy, with decortication after an initial period of penicillin preparation. Twenty-five such cases have been treated by this method since then. The majority of the cases in this series have been treated at a Thoracic Center in the North African Theater of Operations. This paper represents an account of that experience. All cases in this group were definite empyemas. In two, however, there was failure to obtain positive cultures from the pleural pus. This is not a higher incidence of failure to obtain growth from pus than one would encounter in any series of 25 cases of empyema, particularly since the use of the sulfonamides and penicillin is so widespread. All had clinical evidence of infection: *viz.*, fever, anorexia, malaise and the clinical appearance of toxicity. The majority were acutely and severely ill. At operation, all had definite pus in the pleural cavity.

The selection of cases was in the direction of leaving the less severe ones to be handled by simple rib resection drainage, and choosing those with the more complete types of empyema; *i.e.*, those most likely to develop chronic empyema. If the empyema was total, or if the apex was involved in the collapse, the case was selected for thoracotomy with decortication. Sizeable (above 1.5 cm. in greatest diameter) intrapulmonary foreign bodies were considered important reasons to perform thoracotomy-decortication procedures when the empyema was less than total. Intrapleural foreign bodies were considered an even more important indication for operation. Failure of the lung to reexpand progressively and quickly (within four weeks) after adequate rib resection drainage was also considered a most important indication to open the chest and decorticate the lung.

Though we feel that thoracotomy with decortication without preliminary drainage to be the method of choice a few cases in any series will be too sick initially to withstand major surgery. In these, of course, a preliminary rib resection drainage will be necessary. Eight of the 25 cases in this series presented this type of problem.

For the small basal empyemas as well as for the smaller encapsulated empyemas in other regions of the thorax we believe properly placed drainage to be the method of choice. These seldom give rise to persistent cavities if properly drained.

All the cases were males between the ages of 18 and 30.

The essential data on these 25 cases is summarized in Table I. Complete case records of Cases 6 and 22 are included, and are representative of the series.

REPRESENTATIVE CASE RECORDS

Case 6.—This patient sustained severe multiple penetrating shell fragment wounds of the right thorax, right arm, and right thigh on March 26, 1944. First aid was administered immediately by the Company Aid Man, and the patient promptly moved to the Aid Station, where plasma and morphia were given. Within 12 hours of wounding he was admitted to a Forward Evacuation Hospital, where all wounds were débrided and the patient transfused. The patient was again wounded when the hospital

was bombed, suffering a severe laceration of the scalp from a bomb fragment. This wound was débrided and sutured. Signs of right hemothorax were increasingly apparent and a thoracentesis was performed March 31, 1944, which yielded 1,100 cc. of serosanguineous fluid. Thoracenteses were repeated on April 1 and April 5, yielding 1,050 cc. and 1,000 cc. of similar fluid, respectively. On April 9, patient was admitted to the Chest Center in the Base. Examination revealed a moderately febrile patient, who appeared acutely ill but in no significant respiratory distress. Signs of intrapleural fluid were present on the right. A healing scalp wound and an infected wound of the right thigh were present. The débrided wounds of the right arm and right thorax were clean and granulating. A thoracentesis, performed April 9, returned 750 cc. of dark bloody fluid with an offensive odor. Cultures were made of this fluid. Six hundred fifty cubic centimeters of similar fluid were removed on the following day and on April 11, 625 cc. were obtained. On April 12, cultures of the previously obtained pleural fluid were reported positive for *Clostridia*. Systemic penicillin was begun on this date, the patient being given 25,000 units intramuscularly every three hours. The temperature at this time was running from 101° to 102° F., rectally. The patient appeared mildly toxic and was anorexic. On April 13, the fluid from the right chest was even more offensive and showed early purulent transition. A roentgenogram of the chest showed a marked intrapleural process on the right side, with considerable pulmonary collapse, the apex being compressed to the level of the fifth rib posteriorly. An intrapleural metallic foreign body could be visualized (see Figure 7A). The institution of penicillin therapy did not result in any reduction in fever but did seem to bear favorably upon the patient's appetite and general condition. Specimens of pleural fluid continued to become progressively more purulent, and the organism was identified as a definite pathogenic proteolytic *Clostridium*. Repeated blood transfusions were given, bringing the patient's red blood cell volume up to 40. On April 18, 1944, 23 days after injury, and after six days on penicillin protection, immediately following excision and suture of the wound of entry, a thoracotomy with evacuation of the pus, and decortication of the lung was performed. A right posterolateral incision was made and the pleural cavity entered through the sixth interspace. A large hemothoracic envelop was found containing a large amount of very foul-smelling pus, liquefying blood clot and fibrin. A metallic foreign body was found lying free in the empyema cavity. No fistulae were present. The lung was collapsed an estimated 75 per cent. The pus was aspirated, the cavity cleansed with saline irrigations, and a line of cleavage readily found between the visceral pleura and the fibroblastic membrane. The latter measured 4 mm. in thickness (see Fig. 3). This membrane stripped readily from the pleura and the entire lung decorticated easily. After decortication, the visceral pleura presented an entirely normal appearance. Once this has been accomplished the lung reëxpanded completely, filling the chest and obliterating all pleural "dead space." No leaks were present in the lung. The pleural cavity was again irrigated with physiologic saline solution and an internal intercostal nerve block with 1 per cent novocaine done. Anterior and posterior intercostal "water-seal" catheters were placed, the former in the second interspace in the midclavicular line, and the latter in the eighth interspace in the posterior axillary line. The chest was then closed, using silk throughout. Twenty-five thousand units of penicillin in 100 cc. of sterile water were injected into the chest through the catheters and the catheters clamped. Fifteen hundred cubic centimeters of whole blood were given during the operation. The patient was bronchoscoped at the completion of the operation. Following operation the posterior catheter was left clamped for six hours to allow the penicillin to remain within the pleural space. The anterior catheter was connected to a "water-seal" bottle to permit the egress of trapped air.

The postoperative course was entirely uneventful. Defervescence was prompt, the temperature reaching normal on the fifth day, and remaining so. The anterior catheter was removed on the second postoperative day. The wound healed without infection, and

the sutures were removed on the seventh postoperative day, at which time the patient was allowed up. Penicillin was discontinued on the eighth postoperative day. The patient's convalescence was rapid and a roentgenogram made three weeks after operation showed a clear chest, with a completely expanded lung (see Fig. 7B). He was discharged to full duty, completely cured on June 5, 1944, only 70 days after injury. We have since learned that he accompanied his combat outfit in a recent amphibious operation.

Case 22.—This patient suffered a penetrating shell fragment wound of the left thorax on June 1, 1944. He was given almost immediate resuscitation and within 20 hours of injury had been admitted to a Forward Evacuation Hospital, where intercostal nerve block, thoracentesis and débridement of the wound of entry was done. Thoracentesis on June 2 was productive of 300 cc. of bloody fluid and, on June 3, 750 cc. of similar fluid were removed. On June 5, 500 cc. were obtained, and at this time it was noted that the fluid had an early purulent character. The patient was admitted to the Chest Center June 6, 1944. Upon admission, he was acutely ill, slightly cyanotic and moderately dyspneic. The temperature was elevated, and patient appeared toxic. Roentgenograms of the chest showed an extensive left-sided intrapleural process, with apical collapse, and an intrapulmonary metallic foreign body (see Fig. 12A). Thoracentesis yielded 250 cc. of thin sanguino-purulent material, with a foul odor. A culture of this was positive for proteolytic *Clostridia*. On June 7, 1944, systemic penicillin was started, 25,000 units being given every three hours. Daily blood transfusions of 500 to 1,000 cc. were given. Thoracotomy with decortication was performed June 8, 1944, one week after injury. A left posterolateral incision was made and the pleural cavity entered through the sixth interspace. A large empyema cavity was found. This was filled with thin, malodorous pus. A fistula, two centimeters in diameter, was present in the base of the upper lobe at the fissural margin. Investigation of the fistulous opening showed it to communicate directly with a pulmonary abscess, four centimeters in diameter, with the lung in the collapsed state. The metallic foreign body, an irregular piece of shell casing, 1.9 cm. in its largest diameter, was found lying free in the abscess cavity. The empyema cavity was aspirated free of pus and fibrin masses, and the "peel" decorticated from the visceral pleura. The "peel" stripped off readily, leaving a normal glistening visceral pleura. The lung reëxpanded to fill the hemothorax. A laceration extending into the abscess, presenting a fistula in the upper lobe, was enlarged and the foreign body removed. The lining of the cavity was débrided by sharp dissection down to normal lung tissue. The defect in the lung was then closed in layers. Intercostal nerve block with novocaine of nerves three to nine, inclusive, was done, and the anterior and posterior intercostal catheters placed, as described in Case 6. The chest was closed in layers, using fine, interrupted silk sutures. Twenty-five thousand units of penicillin in 100 cc. of sterile water were introduced into the pleural cavity through the catheters and the catheters clamped. The patient was bronchoscoped at the conclusion of the operation. Fifteen hundred cubic centimeters of blood were given during the procedure. On being returned to bed the anterior tube was connected to a "water-seal" bottle, the posterior tube being left clamped for six hours. Despite the extensive operative procedure the patient manifested very little postoperative reaction and the temperature and pulse returned to normal on the seventh postoperative day (see Fig. 6). The temperature rise on the ninth postoperative day corresponded to the removal of the posterior intercostal tube. The anterior catheter had been removed on the third postoperative day. The temperature and pulse remained normal, and the wound healed without infection. The patient's return to normal activity was rapid. A roentgenogram three weeks after operation showed a completely expanded lung and no intrapleural abnormalities (see Fig. 12B). The patient was discharged to full duty on July 28, 1944, eight weeks after injury, and participated in an amphibious operation within a short time after discharge.

PREOPERATIVE MANAGEMENT

Once the diagnosis of infection within the pleural space was established it was necessary to decide whether or not the case was one that could be handled best by thoracotomy with decortication, or whether simple rib resection drainage was the procedure of choice. It is our definite feeling that it is wisest to perform simple rib resection drainage in those cases where the pleural infection is limited to the basal portion of the thorax or where it is small and encapsulated. A few cases will be too sick initially to subject to the more radical procedure of open thoracotomy, with decortication, and in these a preliminary rib resection and drainage will be necessary. If cavity obliteration and pulmonary reëxpansion was not prompt and satisfactory the case then became a candidate for decortication. Needless to say, proper roentgenologic and laboratory studies had been made to establish an accurate picture of the patient's general condition with reference to pulmonary status, total protein and hematocrit. Studies of the pleural fluid identified the offending micro-organism, and the roentgenograms disclosed the presence of intrathoracic foreign bodies, gave evidence of bronchopleural fistulae, or other lesions.

As soon as evidence of intrapleural infection had been obtained, penicillin therapy was instituted, giving 25,000 units of penicillin every three hours—a total of 200,000 units every 24 hours. Daily transfusions of 500 to 1,000 cc. of whole citrated blood were given until the plasma proteins were restored to a normal level, and until the hematocrit values reached a normal of 40 per cent, or slightly above. The length of time that penicillin was given prior to operation was not uniform. Some patients did well when only 24 hours elapsed from the institution of penicillin therapy until operation. Others, for one reason or another, have been kept on the drug for as long as 17 days before being submitted to operation. It would seem that 48 to 72 hours would be a reasonable and rational period of preoperative penicillin therapy, before undertaking thoracotomy with decortication. Experience has taught that it is useless to await a defervescent phenomenon. That comes only with extirpation of the infected focus.

OPERATIVE TREATMENT

Endotracheal gas-oxygen-ether anesthesia was used in all cases. Unhealed wounds of the affected side were either closed secondarily, or excised and closed, using a separate set of instruments. If the wounds were too badly infected to be closed, or to be excised and closed, they were carefully isolated from the field of incision. In cases where a previous operation for drainage had been performed the drainage site was isolated and dealt with at the time of closure.

A posterolateral incision was made on the affected side just below the angle of the scapula, and the pleural cavity was entered through the sixth interspace in the majority of cases. Occasionally the fifth or the seventh

interspace was chosen, depending somewhat upon the thoracic habitus of the patient but more particularly upon whether one anticipated having to do more at the upper pole or more at the lower pole of the involved hemithorax. The great majority of the operations were performed without costal section or resection, although, in a few, previous operations or comminuted fractures of the ribs made it wise to resect all or part of a rib. Exposure is entirely adequate without costal mutilation and intercostal incision is the method of choice. Upon entering the pleural cavity it is extremely important to free the lung rather widely in all directions from the parietal pleural "peel" if it is adherent in the vicinity of the opening into the chest. If this precaution is not taken extensive damage will befall the lung when the ribs are spread. Since the "peel" on the parietal pleura is to be left it is important to bear in mind during this process of para-incisional mobilization that the proper line of cleavage lies between the two layers of fibroblastic membrane, *i.e.,* the one on the visceral pleura, and the other on the parietal, and not between either pleura and its respective "peel." This relationship can be readily visualized by an examination of Figure 1, where these layers are diagrammatically illustrated. Once this maneuver has been accomplished, rib spreading retractors are introduced and the ribs gradually spread to give exposure. It is important to widen the blades of the retractors gradually to allow for muscular relaxation so that fractures of the ribs, muscular avulsion or pleural tears will not occur.

Pus, clot fragments, and fibrin masses are cleansed out of the empyema cavity and the cavity examined for bronchopleural fistulae. If none exist it is well at this point to thoroughly wash out the empyema cavity with sterile physiologic saline. Decortication of the fibrino-fibrous investment on the visceral pleura is then begun by carefully incising it down to the visceral pleura. This maneuver is materially aided by having the lung "braced," as it were, against the incision by moderate positive pressure inflation. The moment the "peel" is completely disrupted in any segment the underlying lung will, if under positive pressure, immediately herniate through the incision, thus, accurately delineating the desired cleavage plane. The edge of the membrane is then grasped with forceps and the actual decortication begun. This is best done by gently and carefully dissecting with a small, firmly packed gauze "pusher." Particular care not to tear the lung must be exercised at the fissural margins and around fistulae, or healed areas that represent points of entrance or exit of a missile. When the visceral pleura has been completely decorticated the lung should be brought to full re-expansion and the surface carefully examined for tears in the visceral pleura and/or parenchyma. These, if present, are repaired by interrupted sutures of fine silk. Fistulae, if present, are best treated by freshening their margins and closing them with sutures of fine silk.

On three occasions in this series it has been necessary to deal with pulmonary abscesses at the time of operation (Cases 7, 21 and 22). We have elected to open the abscess completely, débride the necrotic lining membrane

by sharp dissection and close the defect in the lung with two or more layers of fine silk in such a fashion that all dead space was obliterated.

It will occasionally be found that after what may be termed the "primary" peel has been removed there will remain small scattered islands of a very thin, but surprisingly tough secondary membrane still adherent to the visceral pleura. These will be observed to be causing creasings and infoldings of the lung that materially hampers 100 per cent reëxpansion, and must be meticulously removed.

If an intrapulmonary foreign body is present of such a size as to warrant removal, there should be no hesitancy in opening the lung, extracting the missile and repairing the lung with fine silk.

No attempt is made to remove the membrane from the parietal pleura. It is mandatory, however, to see that a completely smooth margin is left around the entire circumference of the reflection of the peel from the parietal to the visceral pleura. Cuffs and strands of the unattached membrane can only serve as potential sites for the pocketing of secretions.

The diaphragm will be found almost universally elevated and fixed. While there is no need to decorticate it, yet it is felt wise to free this structure circumferentially and thus mobilize it. Note is made of the costophrenic and cardiophrenic sinuses to see that they are free of clot and membrane.

The entire internal chest wall is inspected and palpated for the presence of rib splinters, or metallic foreign bodies which partially protrude into the chest. If present, these are removed and a smooth surface achieved.

Every effort is directed during the entire procedure to achieve complete pulmonary reëxpansion and complete obliteration of intrapleural "dead-space." Any compromise with this ideal is a certain step toward failure. The operation that ends failing to bring the lung into absolute contiguity with the chest wall, and/or that fails to make certain that it remains there has failed to achieve its purpose, and has little likelihood of succeeding. It is a fallacy to assume that half measures in this direction will, by the generous intervention of providence, or something equally unlikely, result in a cure.

Provision for the maintenance of pulmonary expansion is made by the insertion of two, and frequently three intercostal tubes which are subsequently connected to "water-seal" bottles. One of these is placed in the eighth interspace in the posterior axillary line. This tube is a fenestrated piece of soft rubber clysis tubing of 10-mm. internal diameter. It is carried into the pleural space for a distance of two and one-half to three inches, and its proximal end tacked to the parietal pleural "peel" with one silk suture. For the second tube a small Pezzar catheter (No. 12 or 14) is used, the tip being cut off so that just a flange remains. This is brought out through the second interspace anteriorly in the midclavicular line. If the third tube is employed, it is of the same type as the second, and is brought out through either the fifth or sixth interspace in the midclavicular line. The tubes are clamped temporarily. It may be pointed out here that tubes within the pleural cavity are not, and do not, act as foreign bodies *per se*. They only become that

when they cease functioning in their all-important capacity of maintaining pulmonary expansion, and obliteration of pleural "dead-space." When they cease to facilitate progress in that direction, then, and only then, do they become foreign bodies, and should be removed promptly. If the case has been one in which a previous rib resection for pleural drainage has been performed it is altogether likely that the drainage site will correspond with the site of election for the posterior tube. In these cases we have excised the margins of the wound for preliminary drainage, placed the tube through it, and sutured about the tube so that it was air-tight. Any coincident chest wall defect must be freshened and closed solidly.

Intercostal nerve block with 1 or 2 per cent novocaine is done at this time, blocking two or three nerves above the interspace of entrance and two or three below.

A final copious lavaging of the pleural cavity with sterile physiologic saline is carried out, and the cavity aspirated completely dry. A final inspection is made to assure that a completely clean field is being left. The lung is then brought gradually to full expansion. When the lung is completely out to the chest wall the closure is proceeded with. We have used interrupted silk sutures exclusively. Pericostal sutures are not used.

When the closure has been completed 25,000 units (occasionally 50,000) of penicillin in 100 cc. of physiologic saline are injected into the cavity through the tubes, an equal amount being allocated to each tube. The one or two anterior tubes are immediately allowed to drain under water, but the posterior tube is left occluded for six hours following operation to prevent the escape of the penicillin solution. The patient is bronchoscoped before leaving the table.

Blood is given during the operation, a total of 1,000 to 2,000 cc. being administered during the procedure. Having brought the patient to the operating room with a normal hematocrit it is just as important to have him enter the reparative phase of his course with the advantage of a full compliment of red blood cells, hemoglobin, and plasma protein. This aspect is no less important than the shock-prevention function of blood replacement in the end-result.

POSTOPERATIVE MANAGEMENT

Following the return of the patient to the ward he is placed on his back with the bed level. As soon as the patient has fully reacted, the back rest is elevated and the patient is instructed to breathe deeply and cough at intervals. Morphine is administered as required. Food is permitted, as tolerated, and intravenous fluids are given as indicated. One or two transfusions during the first two or three postoperative days are usually given, depending upon the hematocrit. Systemic penicillin is continued until the tubes are out and the patient has been afebrile for two or three days. The tubes are checked frequently to assure their proper functioning. The anterior catheter is removed as soon as apical expansion has been obtained, and there is no

further oscillation of the water column on cough. This is usually a matter of 48 to 72 hours. The posterior tube is left as long as there is any serous drainage through it. This will vary rather widely. The majority may be safely removed between the seventh and tenth postoperative days.

In the event that a complete cure does not occur, and the patient develops a basal empyema, a two-inch section of rib is removed (usually the eighth) in the posterior axillary line and a large rubber tube introduced and made air-tight. This is connected to a "water-seal" bottle. Procrastination in providing adequate drainage, once a recurrence of the empyema has occurred will inevitably result in a more extensive cavity forming than if proper drainage is promptly instituted.

Sutures are removed on the sixth or seventh day and the patient allowed up. A return to full activity is encouraged as rapidly as is consistent with the patient's strength. Deep breathing and postural consciousness are stressed. Shoulder and arm motion of the operated side are encouraged very early in the postoperative course.

RESULTS

Nineteen of 25 cases obtained primary cure of the empyema. Six of the 25 developed a small recurrent basal empyema. The only deviation from 100 per cent *per primam* wound healing in the entire series was a trivial superficial wound infection which occurred in Case 1. The fever in all instances subsided promptly. Postoperative reactions were remarkably mild. No case developed any evidence of embolic infection during the period of time they were under our observation. To date we have no knowledge of the occurrence of any such complication in any case. The one death in the series occurred eight weeks postoperatively, and cannot be considered an operative death (Case 25).

COMPLICATIONS

Complications have been gratifyingly few. In the 25 cases all wounds healed solidly and *per primam.* In only one case (Case 1) was there any wound sepsis. This was a simple superficial wound infection which cleared promptly. In six instances there was a basal recurrence of the empyema requiring secondary thoracotomy with rib resection. In all, the empyema was much less than the original process and in only one patient is there any likelihood that a further obliterative procedure will need to be undertaken to effect a cure. The one death in the series presented a recurrent empyema, recurrence of multiple bronchopleural fistulae, and bronchopneumonia of the contralateral lung. In Case 21, there was reopening of the abscess and a recurrence of the empyema. This remained localized to the apex and was very much less in extent than the involvement at thoracotomy.

DISCUSSION

We feel that the valid applicability of early reparative surgical measures to the problem of traumatic pleural infection has been demonstrated. In addition to the importance of the early cure of the infection, the complete restoration of pulmonary function as rapidly as possible is clearly of vital importance. Before the present concept could be evolved and applied it was first necessary to demonstrate certain fundamentals. The first of these, the essential nature of the pathology of posttraumatic empyema, grew out of a study of the pathology of hemothorax. The demonstration of the fibroblastic membrane investing the pleurae was tantamount to an understanding of most of the problems involved in the treatment of posttraumatic empyema. This discovery led to the realization of what must be accomplished if a prompt cure was to be obtained. It, likewise, explained many of the cases of chronicity and clearly pointed the course to their prophylaxis. The demonstration of the efficacy of penicillin to control bacterial invasiveness and to thus render surgery safely applicable at the optimum time to obtain the maximal functional result (Lyons, *loc. cit.*), was the second of these fundamentals.

In this series of 25 cases of posttraumatic empyema treated by thoracotomy with decortication, under penicillin protection, there has been no favorable selection of cases. The cases have been representative (Table I). All were clinically ill. All had definite empyemas. In the main, they represent the more severe and complicated types. This was inevitable, since as pointed out in the discussion of the selection of cases, those with only basal or small encapsulated empyemas were treated by rib resection drainage alone. The fact that three cases of associated pulmonary abscess were encountered in the series will demonstrate the fact that favorable cases were not selected. The term pulmonary abscess as used here perhaps requires further description. The abscesses represented, in fact, seriously infected lacerations with cavity formation and suppuration.

An examination of Table I will reveal that the series may be divided readily into two groups. The first group of 18 cases presented only pleural involvement. The second group (seven cases) had in addition to pleural infection, significant pulmonic pathology including three cases of pulmonary abscess associated with metallic foreign bodies, bone fragments, and clothing. This distinction is important in an analysis of the results. Of the 18 cases having no significant pulmonic pathology there were 16 cases of primary cure. The use of the word "cure" indicates that the lung fully expanded and completely obliterated the pleural cavity, and that there was no clinical or roentgenographic evidence of a persistence or recurrence of the empyema during the period of postoperative observation varying from six to ten weeks. In all of the 19 cases classed as cured, the complete obliteration of the pleural space and the disappearance of evidence of infection had taken place within two weeks after operation. Of the two in this group that developed a re-

TABLE I

SUMMARIZED DATA OF CASES

Case No.	Type of Injury	Time from Admission to Base Hospital to Operation	Time from Injury tc Operation in Days	Type of Hemo-thorax	Etiologic Organism of Empyema	Previous Surgical Therapy	Associated Thoracic Pathology at Time of Definitive Therapy	Definitive Therapy	Result
1.	SFW pen. left	26 days	28 days	Liquid	*Hemolytic Staphylococcus*	Débridement. Thoracentesis. Secondary closure	Metallic foreign body, left lower lobe.	Penicillin protection 24 hours. Thoracotomy with decortication. Local penicillin. Penicillin 11 days postoperative	Superficial localized wound infection cleared promptly. Complete primary cure.
2.	SFW pen. right	10 days	35 days	Clotted	*Hemolytic Staphylococcus aureus*	Débridement. Thoracentesis. Celiotomy. Seondary closure	Metallic foreign body, right lower lobe	Penicillin protection 24 hours. Thoracotomy with decortication, removal metallic foreign body from lung. Local penicillin. Penicillin 10 days postoperative	Complete primary cure. No complications.
3.	SFW pen. left	30 days	28 days	Clotted	*Hemolytic Staphylococcus albus*	Débridement. Thoracentesis. Secondary closure	Metallic foreign body, left lower lobe. Comminuted fracture 7th rib left	Penicillin protection 24 hours. Thoracotomy with decortication, removal metallic foreign body from lung. Local penicillin. Penicillin 10 days postoperative	Complete primary cure. No complications.
4.	SFW perf. right	32 days	42 days	Liquid	*Hemolytic Streptococcus*	Débridement. Thoracentesis. Rib resection drainage. Secondary closure	None	Penicillin protection 48 hours. Thoracotomy with decortication. Local penicillin. Penicillin 12 days postoperative	Complete primary cure. No complications.
5.	SFW pen. right	34 days	42 days	Liquid	*Micro-aerophilic Streptococcus*	Débridement. Thoracentesis. Rib resection drainage. Secondary closure	Metallic foreign body, right lower lobe	Penicillin protection 48 hours. Thoracotomy with decortication, removal metallic foreign body from lung. Local penicillin. Penicillin 10 days postoperative	Complete primary cure. No complications.

TABLE I—(*Cont.*)

SUMMARIZED DATA OF CASES

Case No.	Type of Injury	Time from Admission to Base Hospital to Operation	Time from Injury to Operation in Days	Type of Hemothorax	Etiologic Organism of Empyema	Previous Surgical Therapy	Associated Thoracic Pathology at Time of Definitive Therapy	Definitive Therapy	Result
6.	SFW pen. right	9 days	21 days	Clotted	*Proteolytic Clostridia*	Débridement. Thoracentesis. Secondary closure	Intrapleural metallic foreign body	Penicillin protection 6 days. Thoracotomy with decortication, removal intrapleural metallic foreign body. Local penicillin. Penicillin 8 days postoperative	Complete primary cure No complications.
7.	SFW pen. left	16 days	16 days	Liquid	*Nonhemolytic Streptococcus*	Débridement. Thoracentesis. Secondary closure	Metallic foreign body, left lower lobe. Bronchopleural fistulae	Penicillin protection 24 hours. Thoracotomy with decortication, removal metallic foreign body from lung. Closure bronchopleural fistulae. Local penicillin. Penicillin 13 days postoperative	Complete primary cure. No complications.
8.	SFW pen. right	6 days	10 days	Clotted	Definite pus. No organism identified	Débridement. Thoracentesis. Secondary closure	Metallic foreign body, right lower lobe	Penicillin protection 6 days. Thoracotomy with decortication, removal metallic foreign body from lung. Local penicillin. Penicillin 6 days postoperative	Complete primary cure No complications.
9.	SFW pen. left	16 days	19 days	Clotted	*Proteolytic Clostridia*	Débridement. Thoracentesis. Secondary closure	Metallic foreign body, left upper lobe	Penicillin protection 24 hours. Thoracotomy with decortication, removal metallic foreign body from lung. Local penicillin. Penicillin 12 days postoperative	Complete primary cure. No complications.
10.	SFW pen. right	32 days	21 days	Clotted	Definite pus. No organism identified	Débridement. Thoracentesis. Early thoracotomy E. H. Secondary closure	Metallic foreign body, right lower lobe	Penicillin protection 24 hours. Thoracotomy with decortication, removal metallic foreign body from lung. Local penicillin. Penicillin 7 days postoperative	Complete primary cure. No complications.

TABLE I—(*Cont.*)

SUMMARIZED DATA OF CASES

Case No.	Type of Injury	Time from Admission to Base Hospital to Operation	Time from Injury to Operation in Days	Type of Hemothorax	Etiologic Organism of Empyema	Previous Surgical Therapy	Associated Thoracic Pathology at Time of Definitive Therapy	Definitive Therapy	Result
11.	GSW pen. left	3 days	11 days	Liquid	*Proteolytic Clostridia*	Early thoracotomy E. H. Thoracentesis. Secondary closure	None	Penicillin protection 48 hours. Thoracotomy with decortication. Local penicillin. Penicillin 14 days postoperative	Complete primary cure. No complications.
12.	Crush injury to chest	5 days	31 days	Clotted	*Proteolytic Clostridia. Hemolytic Staphylococcus aureus*	Thoracentesis	None	Penicillin protection 48 hours. Thoracotomy with decortication. Local penicillin. Penicillin 10 days postoperative	Complete primary cure No complications.
13.	GSW perf. left	4 days	50 days	Clotted	*Hemolytic Staphylococcus aureus*	Débridement. Thoracentesis. Secondary closure	None	Penicillin protection 24 hours. Thoracotomy with decortication. Local penicillin. Penicillin 13 days postoperative	Small basal empyema requiring rib resection drainage.
14.	SFW pen. left	27 days	36 days	Clotted	*Hemolytic Staphylococcus aureus*	Early thoracotomy E. H.	Metallic foreign body embedded in posterior parietal pleura	Penicillin protection 48 hours. Thoracotomy with decortication. Local penicillin. Penicillin 8 days postoperative	Complete primary cure. No complications.
15.	SFW perf. right	20 days	28 days	Clotted	*Proteolytic Clostridia*	Débridement. Closure sucking wound. Thoracentesis. Secondary closure	None	Penicillin protection 48 hours. Thoracotomy with decortication. Local penicillin. Penicillin 8 days postoperative	Developed intra-abdominal abscess, associated with intra - abdominal foreign body. Primary cure of empyema.
16.	GSW pen. right	30 days	33 days	Clotted	*Proteolytic Clostridia*	Early thoracotomy E. H.	Intrapulmonary foreign body	Penicillin protection 24 hours. Thoracotomy with decortication. Local penicillin. Penicillin 7 days postoperative	Complete primary cure No complications.

TABLE I—(*Cont.*)

SUMMARIZED DATA OF CASES

Case No.	Type of Injury	Time from Admission to Base Hospital to Operation	Time from Injury to Operation in Days	Type of Hemothorax	Etiologic Organism of Empyema	Previous Surgical Therapy	Associated Thoracic Pathology at Time of Definitive Therapy	Definitive Therapy	Result
17.	SFW perf. right	55 days	64 days	Liquid	*Anaerobic Streptococcus hemolytic. Staphylococcus aureus*	Early thoracotomy E. H. Rib resection drainage for empyema	None	Penicillin protection 48 hours Thoracotomy with decortication. Local penicillin. Penicillin 15 days postoperative	Complete primary cure. No complications.
18.	SFW pen. right	18 days	20 days	Clotted	*B. proteus*	Débridement. Thoracentesis. Secondary closure. Reduction compound fracture right femur. Application skeletal traction	None	Penicillin protection 5 days. Thoracotomy with decortication. Local penicillin. Penicillin 16 days postoperative	Basal empyema requiring rib resection drainage. Empyema cleared after secondary drainage. Skeletal traction of femur probably influenced development of recurrent empyema.
19.	SFW perf. right	69 days	78 days	Liquid	*Anaerobic Streptococcus. Sporogones*	Early thoracotomy E. H. Anterior and posterior rib resection drainage for empyema	Multiple bronchopleural fistulae	Penicillin protection 48 hours Thoracotomy with decortication. Local penicillin. Penicillin 8 days postoperative	Complete primary cure. No complications.
20.	SFW pen. left	17 days	42 days	Liquid	*Anaerobic Streptococcus*	Early thoracotomy E. H. Anterior and posterior rib resection drainage for empyema	Multiple bronchopleural fistulae	Penicillin protection 72 hours. Thoracotomy with decortication. Local penicillin. Penicillin 13 days postoperative	Complete primary cure. No complications.
21	SFW pen. right	10 days	14 days	Clotted	*Proteolytic Clostridia*	Débridement. Thoracentesis Secondary closure	Large intrapulmonary abscess right upper lobe, associated with large intrapulmonary foreign body. Bronchopleural fistulae	Penicillin protection 5 days. Thoracotomy with decortication. Débridement closure of abscess. Local penicillin. Penicillin 14 days postoperative	Partial reopening of abscess. Recurrence of apical empyema requiring rib resection drainage. Recurrent empyema less than original process. Progress satisfactory.

TABLE I—(*Cont.*)

SUMMARIZED DATA OF CASES

Case No.	Type of Injury	Time from Admission to Base Hospital to Operation	Time from Injury to Operation in Days	Type of Hemothorax	Etiologic Organism of Empyema	Previous Surgical Therapy	Associated Thoracic Pathology at Time of Definitive Therapy	Definitive Therapy	Result
22.	SFW pen. left	2 days	8 days	Clotted	*Proteolytic Clostridia*	Débridement. Thoracentesis. Secondary closure	Retained large metallic foreign body left upper lobe, with associated intrapulmonary abscess. Bronchopleural fistulae	Penicillin protection 48 hours. Thoracotomy with decortication. Débridement closure of abscess. Local penicillin. Penicillin 10 days postoperative	Complete primary cure. No complications.
23.	SFW perf. multiple right transdiaphragmatic	34 days	47 days	Liquid	*Hemolytic Staphylococcus aureus*	Early thoracoabdominal E. H. Rib resection drainage for empyema	Multiple bronchopleural fistulae	Penicillin protection 17 days. Thoracotomy with decortication. Local penicillin. Penicillin 14 days postoperative	Basal empyema requiring rib resection drainage. Persistent anterior empyema cavity, may require future operative procedure.
24.	SFW pen. left	50 days	61 days	Liquid	*Anaerobic Streptococcus. Pseudomonas*	Early thoracotomy E. H. Rib resection drainage for empyema	Multiple bronchopleural fistulae	Penicillin protection 11 days. Thoracotomy with decortication. Local penicillin. Penicillin 16 days postoperative	Recurrent basal empyema requiring secondary rib resection drainage.
25.	Multiple perf. SFW severe	18 days	28 days	Clotted	*Proteolytic Clostridia Sporogones*	Rib resection drainage for empyema	Multiple bronchopleural fistulae. Multiple small intrapulmonary abscesses, with long connecting missile tracts	Penicillin protection 72 hours. Thoracotomy with decortication. Local penicillin. Penicillin 16 days postoperative	Basal empyema. Recurrence of bronchopleural fistulae. Bronchopneumonia contralateral side. Death after 8 weeks.

Explanation of abbreviations.

SFW — shell fragment wound.
GSW — gun shot wound.
pen. — penetrating.
perf. — perforating.
E. H.— evacuation hospital.

current basal empyema following decortication, one (Case 18) occurred in a patient who had a fracture of the femur treated by traction throughout his postoperative thoracotomy course. The immobility of the patient thus engendered, we feel to have been contributory to the failure to obtain a primary cure in this case. It is to be stressed here that whenever long bone fractures occur in association with significant thoracic trauma the fracture should if possible be handled in such a fashion as to render the patient maneuverable. In our experience, a thoracic injury that is immobilized by skeletal traction for the treatment of a long bone fracture is very likely to do badly so far as the chest lesion is concerned. The second case with recurrent empyema in this group (Case 13) presents no reason, so far as we can see, for having failed to achieve a primary cure.

It is significant that of the six cases of recurrent empyema, four occurred in the second group; *viz.*, those with significant associated pulmonary pathology. These associated lesions were serious and complicated. A review of these lesions as summarized in Table I is interesting. Three cases of pulmonary abscess were encountered. All three were débrided and the remaining defects closed. In two of these (Cases 7 and 22), complete healing of the abscess with primary cure of the empyema was obtained. The third abscess (Case 21), much larger, reopened, and gave rise to a recurrent empyema. Despite this, we feel that these cases justify the validity of the method, and that they are striking evidences of the marked extension of surgical therapy that penicillin protection permits of in the eradication of sepsis.

In only one of the cases (Case 23) is there any likelihood that subsequent additional surgery will be necessary to effect a cure.

The consistently uneventful convalescent period and lack of any evidence of dissemination of infection is best appreciated perhaps by a study of the temperature and pulse records of the patients. For this purpose Figures 4, 5, and 6 are included. Figure 4 is the temperature and pulse chart of Case 8, Figure 5 is the temperature and pulse record of Case 20, and Figure 6 is that of Case 22. The absence of any marked reaction to operation is striking and was characteristic of the entire series. Even in the case that eventuated fatally (Case 25) the early postoperative course was favorable. Defervescence has been prompt in all cases. Where the empyema has recurred the temperature reaction was minimal.

The prompt and complete degree of pulmonary reëxpansion obtained in the 19 cases of primary cure is illustrated by the series of photographs of pre- and postoperative roentgenograms, which are included (Figs. 7, 8, 9, 10, 11, and 12). All of these were made within three weeks from the time of operation. They clearly demonstrate the early return to normal and the lack of any evidence of residual disease.

Not the least gratifying and impressive aspect of this series was the short time-interval necessary to effect a cure. Beside the weeks of daily dressings and tube changes required by the other methods these cases present a very

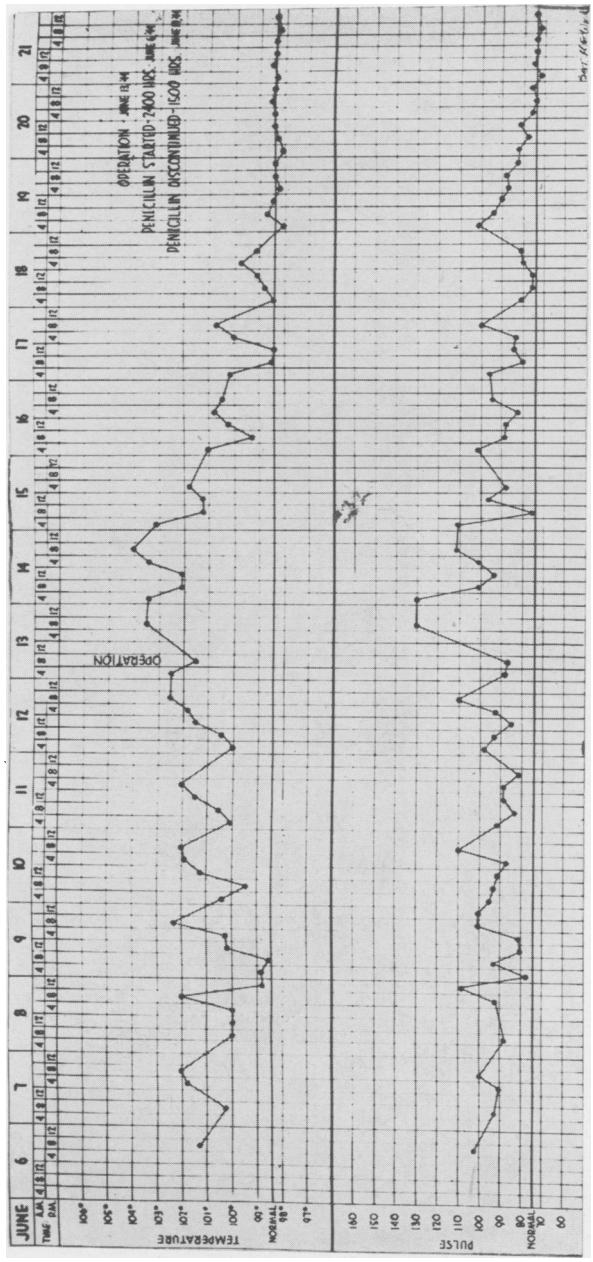

FIG. 4.—Temperature chart of Case 8 showing reaction to operation and prompt defervescence following decortication.

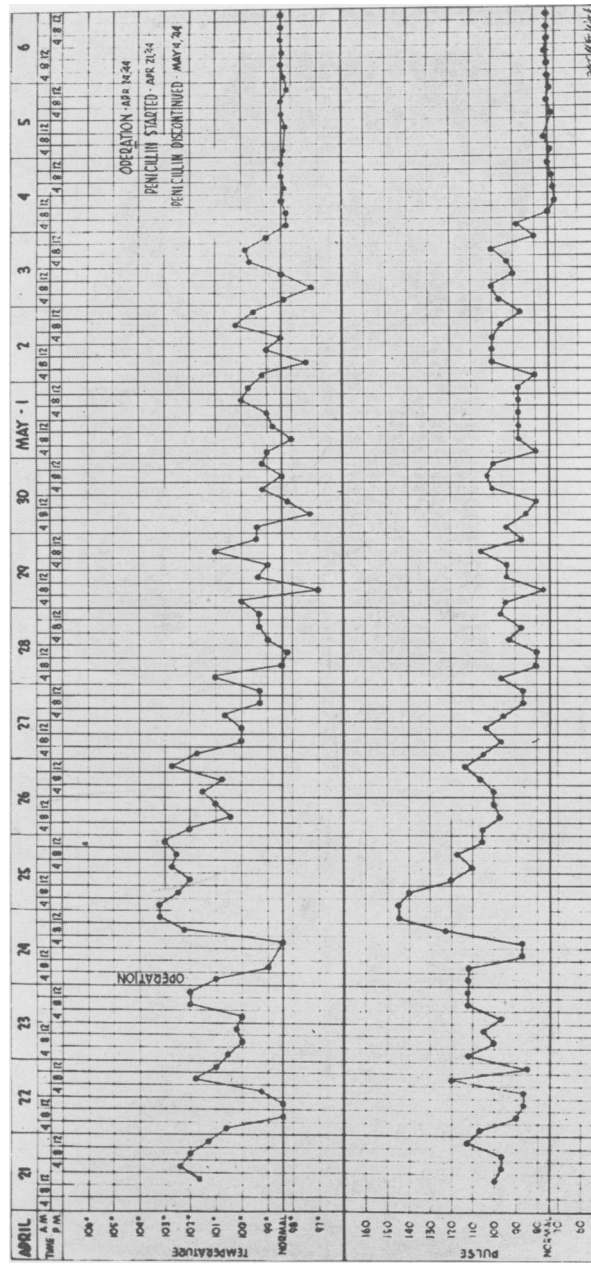

FIG. 5.—Temperature and pulse chart of Case 20 showing minimal reaction to operation and prompt return of pulse and temperature to normal.

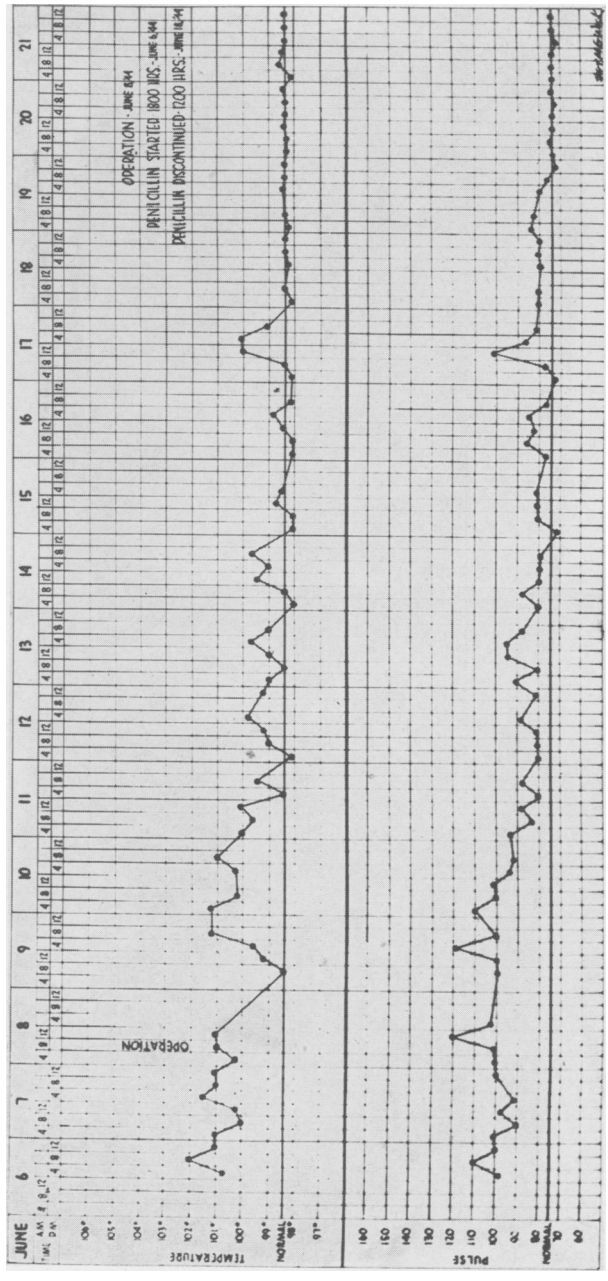

FIG. 6.—Temperature and pulse chart of Case 22 showing absence of any untoward reaction to operation and prompt lysis to normal temperature. The temperature spike on June 17 followed removal of the posterior intercostal tube.

FIG. 7

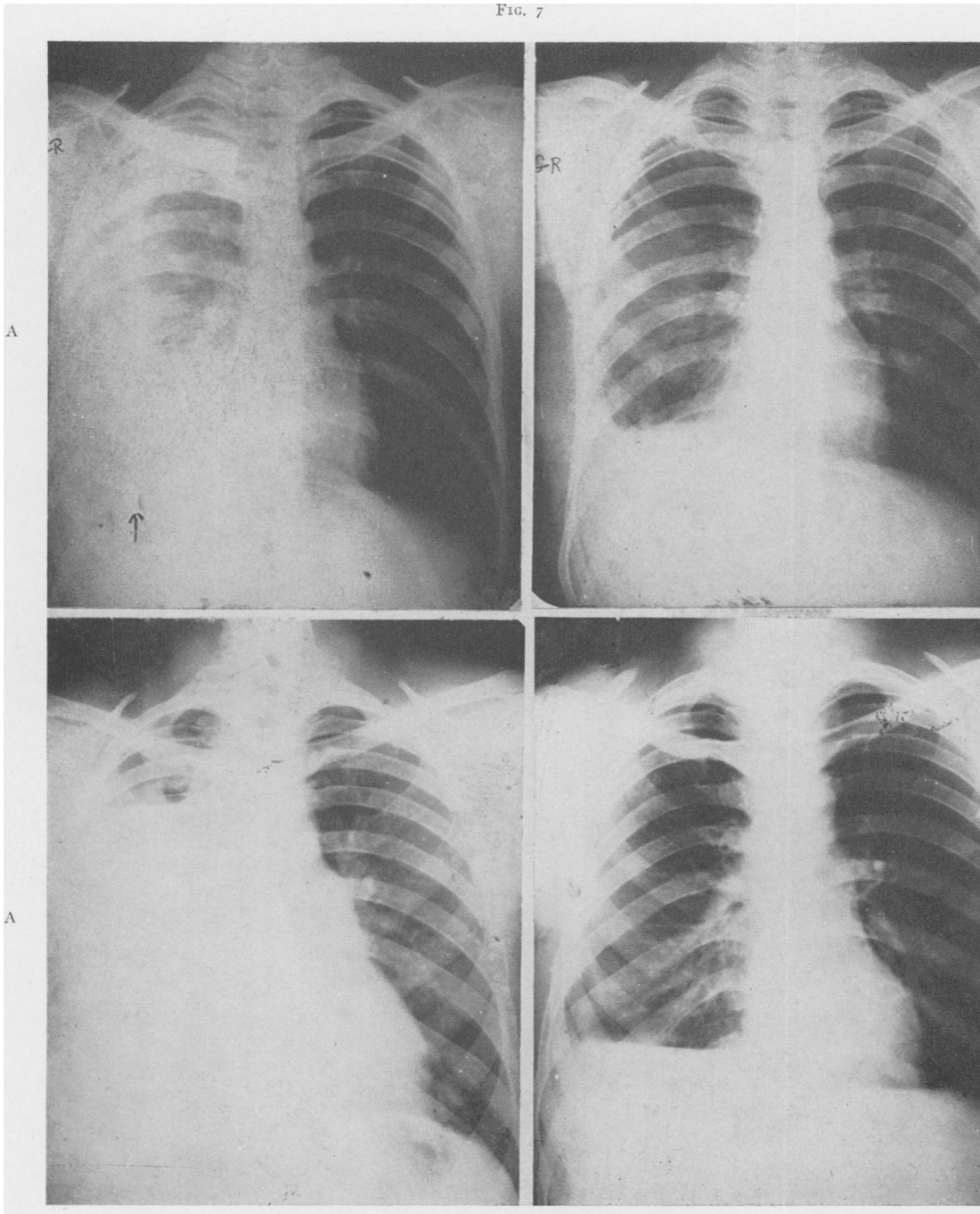

FIG. 8

FIG. 7.—Case 6: A. Roentgenogram of chest at the time of operation showing empyema of right pleural cavity with intrapleural foreign body.
B. Roentgenogram of chest three weeks after thoracotomy with decortication.
FIG. 8.—Case 8: A. Roentgenogram of chest showing organizing hemothorax, with empyema of right pleural cavity.
B. Roentgenogram showing chest two weeks after thoracotomy with decortication.

FIG. 9

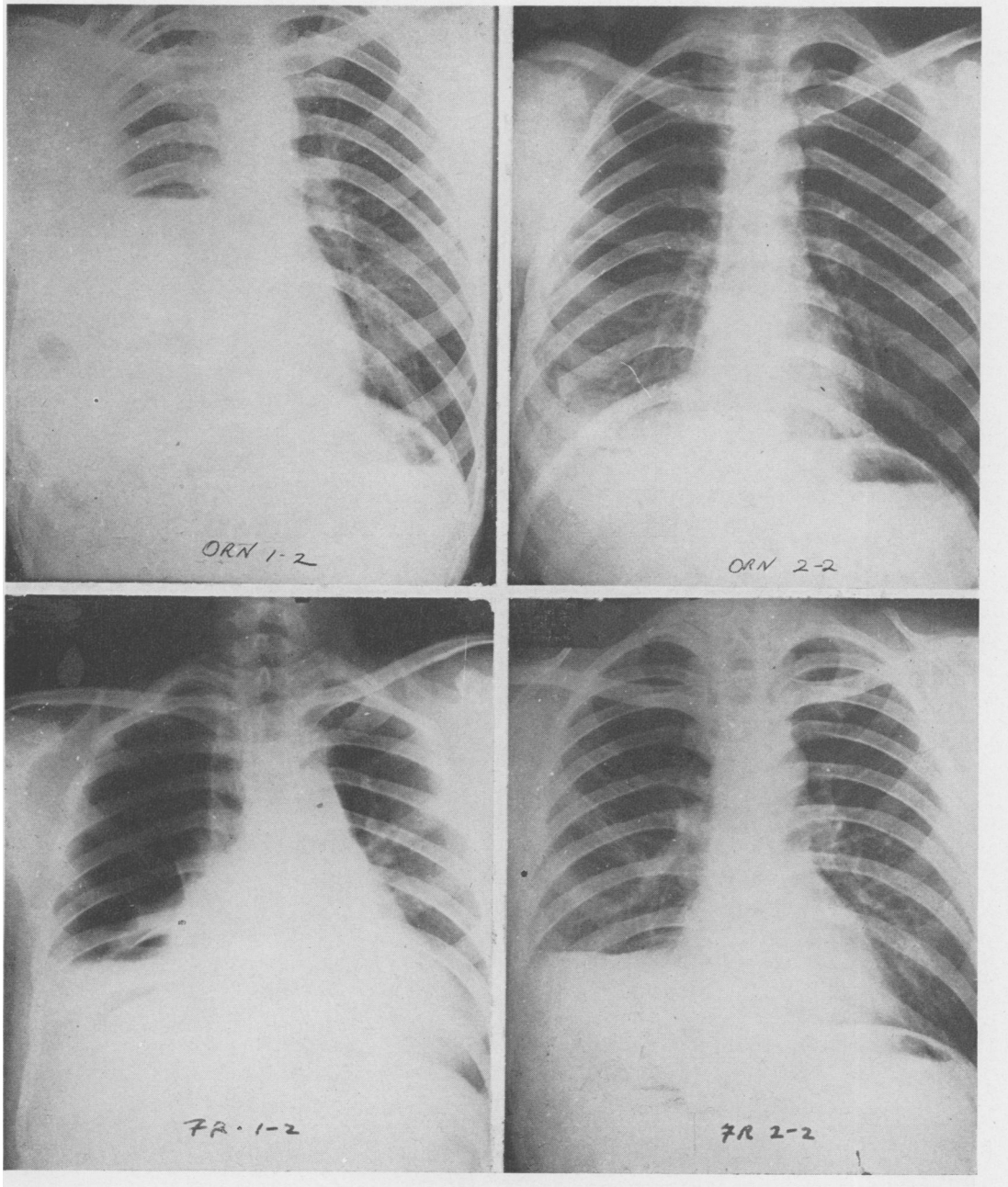

FIG. 10

FIG. 9.—Case 10: A. Roentgenogram of chest showing empyema of right chest. Patient was operated upon at this stage.

B. Roentgenogram of chest two weeks after thoracotomy with decortication.

FIG. 10.—Case 17: A. Roentgenogram of chest showing empyema of right chest, with complete collapse of right lung.

B. Roentgenogram of chest three weeks after thoracotomy with decortication showing complete expansion and no empyema.

FIG. 11

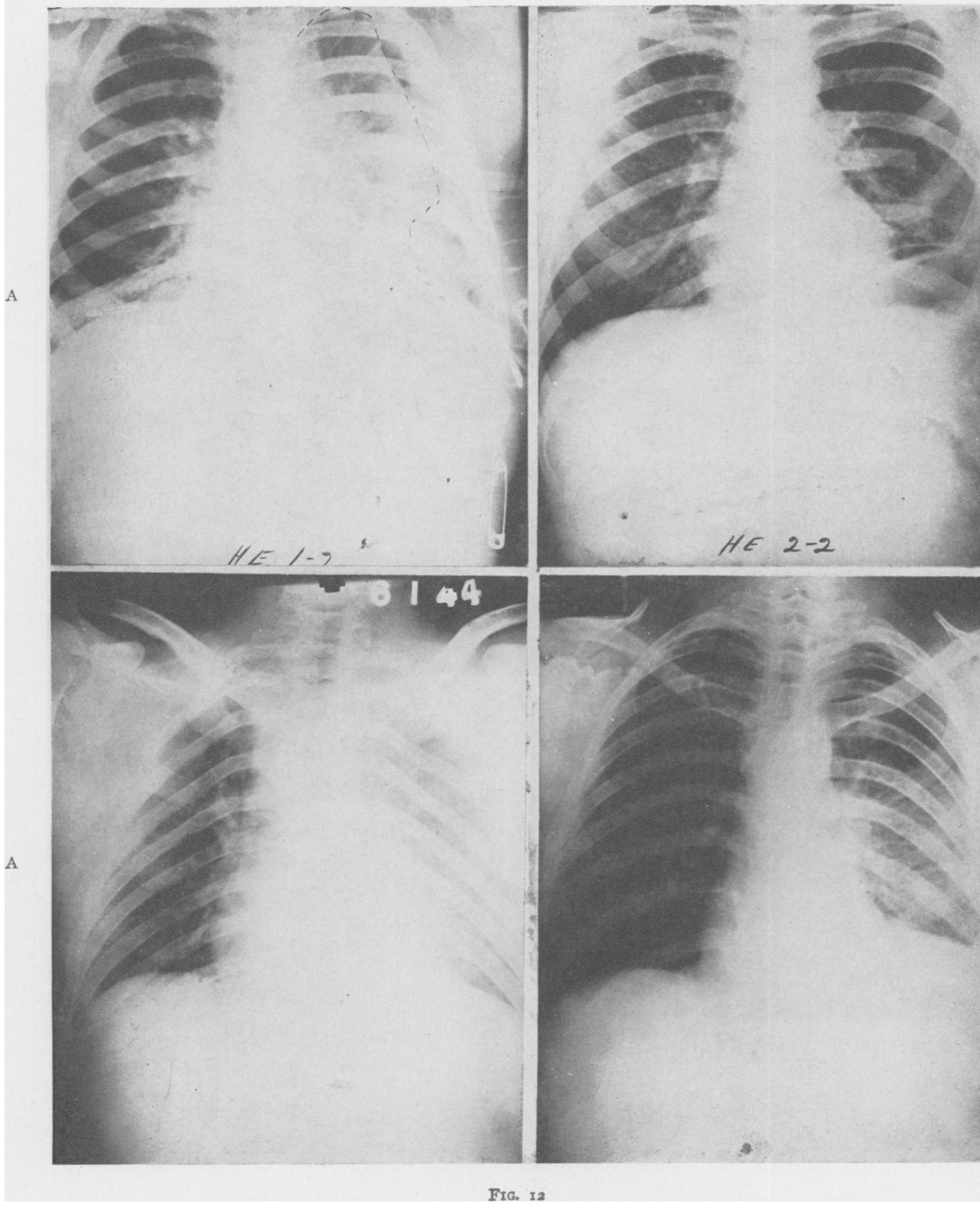

FIG. 12

FIG. 11.—Case 20: A. Roentgenogram of chest showing left-sided empyema of six weeks duration. B. Roentgenogram of chest one month after thoracotomy with decortication showing complete cure.
FIG. 12.—Case 22: A. Roentgenogram of chest showing left-sided empyema thoracis. This patient was found at operation to have a definite abscess of the upper lobe associated with the intrapulmonary foreign body.
B. Roentgenogram three weeks postoperatively.

striking and satisfactory contrast. With solid, cleanly healed wounds and totally expanded lungs the primary cures are very shortly back on the road to complete convalescence. Figure 13 is a striking photograph of a group of five of the 19 primary cures and illustrates their physical well-being within two to three weeks after thoracotomy with decortication.

The disposition of the 24 surviving patients in this series was as follows: Nine were returned to duty in this Theater. Of these, two were sent to full duty, and seven to limited duty, with the recommendation that their duty

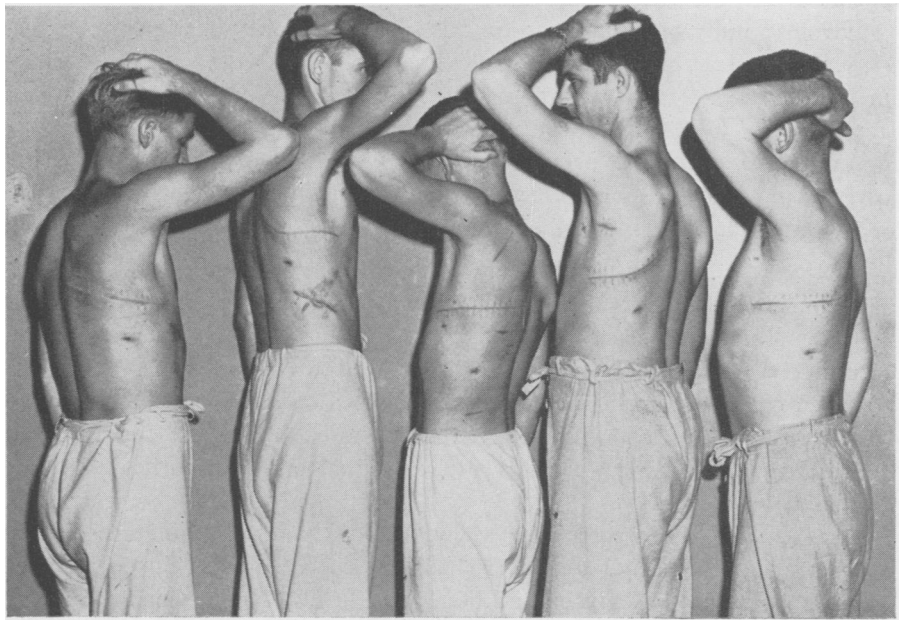

FIG. 13.—Photograph showing five of the cases presented in the text. These cases all had definite empyema, and are shown two and three weeks after thoracotomy with decortication. All in this group returned to duty.

status be reviewed within 90 days. The remaining 15 were sent to the Zone of the Interior. This group included the five recurrent empyemas who survived. Two of the remaining ten were sent to the Zone of the Interior because of concomitant lesions. The remaining eight, though cured of their empyema, had not progressed quite to the point, so far as vital capacity and general physical condition was concerned, where it was felt advisable to return them to duty in this Theater.

From our experience we are convinced that a proper alherence to the principles we have discussed should result in a 90 to 95 per cent primary cure-rate in those cases having only pleural involvement. In those having significant associated pulmonary damage the incidence of recurrent empyema will be higher. However, the process will be greatly shortened and the chances of a chronic empyema will be markedly minimized. Those requiring subsequent mutilating obliterative operations should be very few indeed.

To those who would hold a brief for a more conservative approach to the therapy of posttraumatic empyema we emphasize the not insignificant mortality of the adequately drained empyema that "is doing well." Even the best managed case is unpredictable and the road from drainage to complete cure is beset with significant dangers. It requires but one metastatic brain abscess to emphasize this. Chronicity may eventuate at any stage. At best, the time elapsing before a cure is obtained is a matter of weeks. Uncertainty of outcome is inevitable so long as any vestige of an empyema cavity exists.

From a study of the 25 cases in this series we believe that early thoracotomy, with decortication, under penicillin protection is the method of choice in the therapy of total posttraumatic empyema. We feel that we can now approach the problem of posttraumatic empyema more rationally and more optimistically, certain of achieving a high percentage of primary cures, with early, complete functional restoration and a greatly lowered chronicity rate, with a minimum of risk to the patient.

SUMMARY AND CONCLUSIONS

1. The significance of the problem of posttraumatic empyema thoracis is presented and the basic pathology of the problem, which has been studied intensively, is discussed.

2. A concept of therapy has been rationalized on a basis of that pathology, and a plan of treatment is presented which is based on that concept. The treatment recommended consists of early pulmonary decortication under penicillin protection.

3. A series of 25 cases treated by this method are reviewed. Of this group, 19 (76 per cent) obtained a primary cure. Six developed recurrent basal empyemas. In only one is there any likelihood of a subsequent obliterative operative procedure being necessary to bring about a cure. The one death in the group occurred eight weeks after operation of continued sepsis, and is not classed as an operative death.

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