ACUTE THORACIC EMPYEMA.

By C. PRICE THOMAS, F.R.C.S.

THE term "Thoracic Empyema" indicates the presence of pus in the pleural cavity or any part of it. The modes of infection of the pleural cavity are:—

(1) *By the blood-stream*, as in the acute specific fevers, where the pleura is involved often with other serous surfaces giving rise to a polyserositis.

(2) *Through the chest wall* either by trauma or by disease. In trauma, infection may be carried in by the wounding agent, or a hæmothorax may be formed and this be secondarily infected.

(3) *By lymphatic spread* (a) from the lungs, which are the site of an inflammatory lesion; the infection tracks along the lymphatics to a subpleural position where either small blebs are formed which secondarily rupture into the pleura or, as Graham has experimentally demonstrated in his heart and lung preparation in an artificial thorax, by the pump-like action of the thorax on the œdematous lung where the inspiratory enlargement of the thorax fills the lymphatic spaces and the succeeding expiratory contraction expresses the infected lymph into the pleural space; this latter explanation being the more likely, it also probably accounts for the rapid development of the effusion in the streptococcal cases. (b) From the abdomen by a spread through the lymphatic crypts of the diaphragm, which are in contact with the subpleural tissue.

(4) *By rupture of a septic focus*, either from the lung, mediastinum or abdomen through the diaphragm.

The commonest *organisms* found are pneumococci and streptococci, though staphylococci, anaerobes and *B. coli* are not uncommon, and more rarely, *B. typhosus* and others.

The *effusion* is in the early stages serous; it, however, soon becomes seropurulent and after a varying length of time it becomes frankly purulent. It has been stated that an empyema is an empyema from its inception without a preliminary serous stage, but it is very doubtful whether this ever occurs except perhaps rarely in those cases where a septic focus such as a lung or mediastinal abscess suddenly ruptures into the pleura; it is, however, common for pus to be present when an empyema is first recognized.

The serous and seropurulent effusions are thin, containing very little fibrin, but later they become more cellular and the fibrin content increases, the latter being deposited on the lung surface and the chest wall, and it is this which, if it is left to organize, restricts lung expansion and so prevents obliteration of the cavity. Pneumococcal cases produce fibrin in large quantities fairly early in their course, but streptococcal ones take some little time before this is achieved, a fact with important bearing on the treatment.

Empyemata are classified under the following headings:—

(1) *Complete or total*, where the lung has not formed any adhesions either to chest wall or diaphragm; this type is very rare and generally of fulminating character, mostly of blood-borne origin, associated with a general disease, and the commonest infecting organism is a hæmolytic streptococcus.

FIG. A.—Large empyema in a child, showing displacement of the heart to the right, also of the trachea.

FIG. B.—A sacculated parietal empyema, occupying the apical region on the right side. Note the edge is sharply defined. No consolidation of the adjacent lung.

FIG. C.—Large basal pulmonary abscess with fluid level. This can be differentiated from a sacculated empyema by the fluid level and, above all, by the amount of pulmonary consolidation.

FIG. D.—Right-sided interlobar empyema showing the sharply delimited upper margin of the shadow.

FIG. E.—Lateral view of right-sided interlobar empyema (not the same as the previous case), showing the lozenge-shaped shadow fissure between the upper and middle lobes.

(2) *Sacculated parietal*, where the lung is adherent to the chest wall and diaphragm for a variable distance; the largest group of empyemata fall into this type.

(3) *Interlobar*, where the collection of pus is between the lobes in the interlobar fissure and in the early stages has no communication with the general pleural cavity.

(4) *Diaphragmatic empyema*, where the collection is between the diaphragm and the lower aspect of the lower lobe.

(5) *Mediastinal*, where the collection is between the mediastinal pleura and the lung; this being a rare type.

Before proceeding to discuss the clinical features and treatment of empyemata, it is well to recall certain facts in connection with the physiological mechanics of the thorax. The thorax can be looked upon as a bony cage which by means of its musculature is capable of enlargement and contraction; it acts as a protection for its contents, and also as a barrier to atmospheric pressure. The thoracic cavity is split up into three compartments, the two pleural sacs with the mediastinum intervening and the pericardium; it is important, however, to realize that these separate cavities are

FIG. 1.—A, complete or total empyema; B, sacculated parietal empyema (the common type).

not rigid structures and that, as Graham has shown, pressure in one pleural sac is within limits nearly equally distributed on the other.

The lungs, which normally are in contact with the chest wall, expand and contract with the chest wall, air rushing in and out through the glottis in the act of respiration. During quiet respiration, 500 c.c. of air are inspired and expired in each act, this is known as tidal air; if, at the end of quiet inspiration, a full inspiration is taken, a further 1,500 c.c. of air is inspired and this is known as complementary air; if at the end of quiet expiration a full expiration is given, 1,500 c.c. of air are expired and that is known as supplemental air. The sum total of these three is known as the vital capacity. These figures are low, for a normal man the vital capacity being between 4,000 c.c. and 5,000 c.c. or over.

It used to be believed that an **open pneumothorax** in a normal chest was incompatible with life, this was then modified to a statement that the opening in the chest wall must not be larger than the glottis; both of these beliefs have, however, proved to be untenable as a result of experience during the War. Graham and his colleagues have enunciated the factors which appear to give the correct explanation of position;

as has already been stated, they have shown that positive pressure in one pleural cavity is communicated within certain limits to the other, so that when an open pneumothorax exists in a normal chest, not only is the affected lung collapsed but also the opposite lung is compressed and its power of expansion during the inspiratory act is curtailed; however, an open pneumothorax in people with a high vital capacity, that is in those who have a wide margin of reserve, increased respiratory effort will enable them to satisfy their tidal requirements of 500 c.c., but a like condition in those whose vital capacity is so low from any cause that it approximates their tidal requirements, an open pneumothorax would prove fatal from an anoxaemia; thus it will be seen that the safety of an open pneumothorax and the size of the pleural opening depend greatly on the vital capacity of the individual. Its danger lies in the fact that not only is the lung of the affected side compressed, but also the one of the opposite side; consequently, the safety of an open pneumothorax on a patient with a low vital capacity depends on the rigidity of the mediastinum, or fixation of the affected lung to the chest wall in such a manner as to prevent the positive pressure being transmitted to the lung of the opposite side.

Other factors which play a part in the embarrassment of an open pneumothorax are the loss of the aspiration action of the chest on the venous return and so restricting the cardiac output and also the effect of the flapping of the mediastinum on the nerve plexuses causing vagal inhibition. All these facts have a bearing especially on the problem of treatment of empyema.

The diagnosis of empyema rests, as in other diseases, on the history, physical signs and other aids.

The commonest antecedent of the condition is pneumonia either lobar or lobular, but, whereas in lobar pneumonia the empyema follows pneumonia, i.e. it is metapneumonic, in broncho-pneumonia it occurs coincidentally with the pneumonic process, i.e. it is synpneumonic; this question of whether an empyema is meta or synpneumonic, has an important bearing on the treatment in that in the synpneumonic type, the patient's vital capacity is considerably lowered owing to the coexistent pneumonia.

The commonest history is that of the lung affection with often the crisis safely over, and then after a day or a week or more, a rise in the temperature, gradual at first, then rising to 102° to 104° F., the grunting respirations are absent, and although the rate is not increased in the early stages, it may increase from mechanical pressure if the effusion becomes large. There may be a slight unproductive cough; if this becomes harassing, it generally indicates bronchial irritation and perhaps is a precursor of rupture of the collection into a bronchus.

Physical signs are generally clear.

Inspection. Flattening and limitation of movement of the affected side with a drooping of the shoulder of that side, increased obliquity of the ribs, scoliosis with concavity to affected side. Vocal fremitus increased when the effusion is cellular, apex beat may be displaced. Percussion, which is the most valuable physical sign, gives flatness not only of note but of sensation over the area of fluid. Grocco's triangle may be present, but this may occur with a lower lobe pneumonia. Auscultation varies with the cellular contents of the effusion and the thickness of the pleura, in early stages often the classical signs of fluid are elicited with absent breath sounds, decreased

vocal resonance and ægophony at the upper limit, but as the cellular content increases, the signs may be the same as over a consolidated lobe with bronchial breathing and increased vocal resonance and fremitus, but the area does not conform to the pulmonary lobe. Auscultation of the heart is not a good indication as to its position owing to the conduction of sounds easily through fluid.

Blood-counts show a leucocytosis from between 20 and 30 thousand with a polymorphonuclear increase.

X-rays, which are the most valuable aid to diagnosis at our command, should be undertaken in all cases before operative treatment is embarked upon. The screen and films show in the large type a practically complete opacity of the side of the chest with the upper border generally going obliquely upward and outwards towards the axilla. In the smaller sacculated type, there is a round shadow with its base at the chest wall, which may be very difficult to differentiate from a lung abscess, in empyema, however, the edge is generally sharp without any adjacent pulmonary consolidation.

Needling of the chest to discover the pus is, of course, the only positive evidence of its presence, but this should be done guardedly and, if possible, only after the diagnosis that the condition is a parietal empyema has been confirmed by X-rays. This point cannot be too strongly stressed as the risk of infecting the pleural cavity in needling a pulmonary abscess across a free pleura is a very definite one, the complication, if it arises, will increase greatly the mortality. It is good practice to needle the chest only after the diagnosis has been satisfactorily made and then only as a prelude to operation or therapeutic aspiration.

Treatment.—Empyemata used to be looked upon as surgical emergencies, the presence of pus in the pleura calling for immediate rib resection; this practice led to such an appalling mortality, especially in the post-influenzal streptococcal types, that aspiration was attempted, supplemented by rib resection where indicated, at a later date, with a drop in the mortality of these cases from 60 per cent. for early operation to 9 per cent. for aspiration with late operation. The explanation of this is to be found in the facts already referred to, that the streptococcal cases, which are generally associated with bronchopneumonia, occur during the pneumonic process and so have a lowered vital capacity, also that in streptococcal effusions, there is, in the early stages, very little production of fibrin and consequently few or no adhesions are formed until later, so that opening the chest under these circumstances is tantamount to opening a normal pleural cavity in a patient with a vital capacity which approximates closely his tidal air requirements.

It is thus obviously important to recognize the type of case with which one is dealing; the history of the case, of course, will give a shrewd indication, but the safest guide will be the type of fluid aspirated, and the best indication for operation is the withdrawal of thick frank pus. If there should be any doubt, therapeutic aspiration should be practised until thick pus appears. The presence of thick pus means that the fibrin content will be high and consequently adhesions will have formed between the lung and chest wall.

It may be noted here that, as Cameron points out, in children under two years, pneumonia, both lobar and lobular, tends to run a very long course, so that empyemata occurring in them are more commonly synpneumonic, and in these cases, aspiration of the chest should be pushed to extreme limits before rib tube drainage, if indicated, is instituted.

When an empyema has been drained, the only satisfactory end-result is a completely healed and obliterated cavity. The obliteration of the cavity occurs as the result of re-expansion of the lung. The factors which aid re-expansion are intra-alveolar pressure of air and probably the progressive formation of granulations at the edge of the cavity. The factors which militate against the re-expansion are the pressure of the air, or discharges in the pleural cavity and the organization of the fibrin covering the visceral pleural, so that any line of treatment must be designed to obviate these factors.

The method of treatment which provides the most favourable conditions is that of air-tight drainage, which will be described.

The position of the patient depends to some extent on the general condition, the sitting posture, either with the legs over the end of the table, or with sufficient pillows under his knees to make him comfortable and then one on his knees on which to rest his arms and head; in a patient too debilitated to sit, the lateral position, lying on the sound side with an air cushion under the axilla so as to allow free expansion of that side of the chest.

Anæsthesia should preferably be local, as this can be used quite successfully with even young children. The line of incision is infiltrated for about three inches with $\frac{1}{2}$ to 1 per cent. novocain, first a dermal wheal, then subcutaneously, then the muscular layers. The **incision** is made vertically over the eighth rib in the mid-axillary line, unless the position of the cavity demands another site. A vertical incision allows of better drainage of the wound and also allows the tube to seat itself more satisfactorily. The eighth rib is chosen as it will give dependent drainage, the diaphragm not interfering with the tube at this level.

The chest is now needled with an exploring syringe to confirm the presence of pus, and, if found, the muscles are divided down to the ribs and bleeding points are secured with artery forceps. An injection of 1 to 2 c.c. of novocain is now made under the subcostal groove and also at the upper border of the eighth rib, drawing back the barrel of the syringe before making the injection to make sure the point of the needle is not in a vessel. The vessels are now tied off, and when this has been done the periosteum is insensitive enough to commence rib section. The periosteum is incised longitudinally for 2 to $2\frac{1}{2}$ in. and transversely at the ends of the longitudinal incision, it is then stripped off the outer surface to lay bare the upper and lower borders, which are then freed with a Doyen's raspator, the lower border from before backwards and the upper from behind forwards because of the direction of the external intercostal muscles; the deep surface of the periosteum is now separated and $1\frac{1}{2}$ to 2 in. of rib resected with a costatome or bone forceps; it is well to warn the patient that he will hear a crack. The exploring needle is again put into the chest and a small quantity of pus aspirated. The pleura and posterior periosteum are now incised, and the escape of pus is controlled with the finger so as to release the tension and allow the mediastinum to come back slowly. When all tension has been relieved, the cavity is explored with the finger and any subsidiary loculi gently broken down into the main cavity, the pus is aspirated and as much lymph as possible removed with sponge forceps.

A Tudor Edwards empyema tube is now introduced into the cavity; this tube, which is one of the most efficient tubes yet designed, is 8 to $8\frac{1}{4}$ in. long and ranges

from No. 35 to No. 48 Charrier; there is a small tube about No. 8 Charrier incorporated in the terminal 3 in. of the wall of the tube, through which irrigation is carried out; at the end of the tube is a flange, which is introduced into the pleural cavity snugly against the chest wall; there is also a movable flange, slotted to take tapes, which are tied round the chest.

After the tube has been introduced, the incision is closed with figure-of-eight silkworm gut sutures, generally one above and one below the tube; the tapes are now tied around the chest and the dressing applied, and the patient returned to bed.

The patient is nursed sitting up and the pillows are arranged on a bed-rest in such a way as to allow of plenty of room for the tube, which is immediately connected up to a bottle with the glass tube under some mild antiseptic, the small tube being clamped; the attached diagram explains the principle.

After-care.—Efficient drainage is of course essential and care should be taken

FIG. 2.—Tudor Edwards empyema tube. A, chest wall; B, inside flange; C, external flange (movable on tube); D, small irrigation tube inlet into wall of tube.

FIG. 3.—Bottle for under-water drainage which is placed on the floor at patient's bedside. A, Tudor Edwards empyema tube fixed to chest wall with tapes; B, column of fluid in glass tube which should show respiratory excursions if working properly; C, tube to which a suction pump can be attached to produce further negative pressure.

to see that the tube is working; a free respiratory excursion in the glass tube indicates that the tube is free, when this is absent, gently milking the connecting tube will generally start it again. If this does not succeed, then the tube must be disconnected and a gum elastic bougie introduced to break up any mass of fibrin that may be present, on no account must irrigation be attempted through the large tube owing to the risk of producing a dangerous increase in the intrapleural pressure. Irrigations should be started on the fourth or fifth day with warm eusol, making sure, meanwhile, that the large tube is draining freely. Eusol, apart from its antiseptic properties, is a good

solvent of fibrinous exudates, and it should be instilled every four hours. If there is any cough or taste of eusol on irrigating, then this should be stopped as there is a bronchopleural fistula present and the risk of drowning with the irrigation fluid is considerable.

After two to three days the œdema of the chest wall has decreased and the tube will now be projecting into the cavity, so the tube is pulled on until the inside flange is again tight against the pleura and the outside flange is readjusted accordingly.

The temperature will subside in the course of a few days, and often the pulse-rate too, but this may remain in the region of 100 for some time. Drop in temperature and pulse and decrease in the quantity of discharge is not an indication for the removal of the tube, the only indication for this is the approximation of the lung to the chest wall and the best guide is X-ray film; failing this, the distance of the lung from the chest wall can be assessed by introducing a gum elastic bougie through the tube until the lung is felt and if the distance is not more than $8\frac{1}{4}$ in. (the length of the tube), and the physical signs around the wound are those of an expanded lung, then the tube should be removed. No further tube should be put into the wound, but merely superficial sterile dressing applied, and the wound heals in the course of a week or so.

During the whole of the after-treatment, fluids must be given freely to compensate

FIG. 4.—C, interlobar empyema; D, diaphragmatic empyema; E, mediastinal empyema. (After Lilienthal.)

for those lost in the discharge; blowing fluid from one Woolf bottle to another is valuable to increase intra-alveolar tension and so aid lung expansion.

The treatment of acute empyema is not complete until the cavity is obliterated and the wound healed, and the patient should not be discharged until this end has been achieved; neglect of this precaution leads to the production of a chronic empyema, to cure which, extensive operative procedure and great patience on the part of both patient and surgeon is necessary.

The diagnosis of interlobar diaphragmatic and mediastinal empyemata is more difficult than that of the parietal type just described, as physical signs often are absent, the only indications being the general symptoms of toxæmia, blood-count and X-rays, the last being the most valuable. Interlobar empyema in its early stages gives rise to no physical signs as there is lung between the chest wall and the collection of fluid. Later, the fissure sometimes opens at its outer end and the empyema becomes for all practical purposes a parietal one.

X-rays of this type are typical, in the anteroposterior film, there is a sharp upper margin to the shadow which gradually decreases towards the base and in the lateral view there is a sharply demarcated oval shadow in the line of the affected fissure.

The treatment is the same as that for a pulmonary abscess. Exploration with a needle should be avoided as the pleura may be free; operation is undertaken in two stages, at the first session, one or two ribs are resected at the optimum site, which is judged from the anterior, posterior and lateral X-rays, generally the sixth or seventh ribs in the mid-axillary line and when the parietal pleura has been laid bare, a small iodine pack is laid on it and muscles and skin sutured over it; the second operation performed in five to seven days by which time visceral and parietal pleuræ are adherent, the wound is reopened, the pack removed and the wound swabbed clean, and the chest is needled to ascertain the presence of pus; when this is found, the needle is left *in situ* and the cavity is opened with a knife or diathermy point; all the pus is aspirated and an ordinary tube with lateral holes is inserted; there is no need for a suction drain in this or the diaphragmatic or mediastinal types, as in all three the walls of the cavity are soft and will fall together easily. Irrigations, when used, must be done with great care by introducing a rubber catheter of fine bore through the tube, ensuring a free escape from the tube. Bronchial fistulæ must be kept in mind in this type especially, as there is a great tendency here before operation for the pus to burrow into the adjacent lung and be coughed up. The tube should be made shorter and a smaller tube used as the cavity contracts, and discharge becomes less, but premature removal of the tube should be avoided.

Diaphragmatic empyema (refer fig. 4) may give rise to shoulder pain or may be associated with vomiting, but, as in the previous type, X-rays generally give the clue to the condition, it may be difficult, however, to decide whether the collection is above or below the diaphragm; on the left side the gastric gas bubble gives the position of the diaphragm, a seidlitz powder will produce a bubble if there is not one present; on the right side a pneumoperitoneum may be necessary to clear up the diagnosis.

The treatment is on the same lines as for the interlobar collection and the same precautions are necessary.

Mediastinal empyemata are very often overlooked until they have been present for some time, pain in the front or back of the chest may be a feature with an irritating cough if the collection is close to the hilum. X-rays are again of the greatest value in the diagnosis, they show a shadow spreading out from the mediastinal one; either hemispherical or a thickening of the mediastinal one; they generally occur below the level of the hilum and may be in front or behind the ligamentum latum pulmonis.

Treatment is along the same lines as the previous type, care however must be exercised as to the site of the intervention, which may be anterior or posterior close to the mid-line.

Conclusions.

(1) X-rays are a most valuable adjunct in the diagnosis of empyema and in ascertaining where the cavity has been obliterated.

(2) Two main groups occur, *Meta and Synpneumonic*. Metapneumonic is most commonly pneumococcal, and synpneumonic most commonly streptococcal.

(3) Exploration with a needle should only be undertaken when the diagnosis

has been established and then only as a prelude to therapeutic aspiration or rib resection.

(4) Therapeutic aspiration should be instituted in all cases until thick frank pus is present.

(5) In those cases where rib resection is necessary, and the bulk of cases will need it eventually, air-tight under-water drainage gives the best results.

(6) No acute empyema should be discharged until the cavity is obliterated and the wound is healed.

PAINFUL BACKS.

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IN recent years a great volume of literature has grown up around the subject of pain in the lower part of the back or, as American writers have called it, "low back pain." Under this title a number of clinical and pathological conditions have been described with a profusion and variety of detail that is quite bewildering.

I believe that the symptoms and signs of most of these conditions have been needlessly elaborated, and that the majority of people who complain of pain in the back are suffering from some simple affection which is easy to recognize and generally not very difficult to treat.

The commonest conditions met with are :—

- (1) The neurotic spine.
- (2) Sacro-iliac strain.
- (3) Lumbosacral strain.
- (4) Acute and chronic (lumbar) back strain.
- (5) Spinal arthritis (osteoarthritis) with or without sciatica.

In addition to these, we meet with cases of true lumbago, Pott's disease, compression fractures of the lumbar vertebræ, and other less common conditions, each of which presents a fairly characteristic clinical picture.

The Neurotic Spine.

This is placed first, not so much on account of its own intrinsic importance, but because of its frequent association with other conditions, and the confusion of diagnosis which so often results. The expression "neurotic spine" does not refer to the comparatively uncommon hysterical condition sometimes met with in young women, but to the condition which almost inevitably arises sooner or later in a patient of either sex who is suffering from long-continued pain in the back. For it is a fact, that in the great majority of the cases presently to be considered a definite neurosis is superimposed upon the genuine organic affection. It varies in degree from a more or less diffuse hyperæsthesia up to a condition of profound neurasthenia, and it has frequently led to the misinterpretation of otherwise straightforward cases. The characteristic feature of the neurotic spine is superficial and variable tenderness, in contrast to the constant and definitely localized pain of the associated condition. The treatment of the neurotic spine is primarily that of the condition which causes it.