REFRESHER COURSE FOR GENERAL PRACTITIONERS

EMPYEMA

BY

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Many pneumonias are cured by antibiotics; the more pneumonias cured, the fewer the empyemas. This accounts for the considerable reduction in the frequency of pleural infection at the present time as compared with, say, eight or ten years ago. Nevertheless, the distressing picture of an established chronic empyema, with toxæmia, loss of lung function, and a deformed chest, should always be kept in mind as a warning of what may happen if the early stages are not recognized, or are improperly treated.

Pathology

Infection of the pleural cavity is commonly secondary to inflammation of the underlying lung. There are other causes, such as penetrating wounds, which must include the incautious use of the aspiration needle in search of a subphrenic abscess, but for practical purposes the lung can be regarded as the primary focus. Tuberculous empyema should be regarded as a separate problem.

The earliest stage of pleural inflammation is the formation of an exudate, usually clear and containing bacteria, but rapidly becoming turbid as the cellular content of the fluid increases. This stage is conveniently referred to as "diffuse suppurative pleurisy," since, in the absence of pleural adhesions, the whole cavity is potentially infected. The characteristic shape of the effusion is the result of gravity opposed by the subatmospheric pressure of the pleural cavity; the usual basal position can be altered by changing the patient's position. The lung is collapsed and pushed aside as the fluid collects, and if a large volume accumulates the mediastinum will be displaced. The amount of fibrin in the effusion varies with different organisms; it is small with streptococcal infections, which are slow to localize, and is much more massive in the presence of the pneumococcus. Within a few days of onset the fluid is frankly purulent and fibrin is being deposited on the chest wall and over the lung surface; flakes, and even masses, of fibrin float loose in the effusion. At this stage lung and chest wall become adherent at the margins of the fluid and a "localized pleural abscess" can be said to be forming. An abscess with appreciable walls develops in 10 to 14 days, and if not treated the fibrin walls become firmly organized and rigid, progressively binding down the lung and preventing the chest wall from moving. This fibrin capsule is three or four times as thick over the chest wall as over the lung surface.

Diagnosis

The early signs of fluid over a consolidated lung are not always easy to make out. Dullness is more marked and breath sounds are more distant or absent with aegophony towards the thin margins of the fluid, but it is often difficult to be certain that a thin layer of fluid is or is not present when the signs in the lung are still well marked. This applies particularly to children. Later, increasing loss of movement and absence of air entry make the diagnosis more certain, and radiology can give considerable help so long as the film taken is a good one. Too often the use of indifferent or portable apparatus fails to give the necessary help. There is only one certain method of diagnosis: that is, aspiration of infected fluid.

The diagnosis should be easily established when there is enough fluid to produce pressure on the mediastinum. In

such cases marked shortness of breath and even cyanosis are added to the clinical signs, which include shifting of the apex beat and angulation of the trachea from the midline in the suprasternal notch.

Principles of Treatment

The principles that underlie treatment are twofold: (1) the toxæmic element must be eliminated and the products of inflammation moved from the pleural cavity, and (2) the lung must be re-expanded at the earliest possible moment, before it has become pinned down by fibrous tissue. This second factor is too often lost sight of because in other parts of the body drainage of an abscess (in the pelvis, for example) is followed by spontaneous obliteration of the cavity as the soft walls come together. In the thorax, however, the rigid chest wall and the collapse of the lung produce a firm-walled space which, if not treated correctly, may persist.

Treatment starts from the moment the diagnosis is made certain. Aspiration not only proves the presence of fluid or pus, but enables bacteriological examination to be carried out. In the early stages, as has been indicated, during the process of diffuse suppuration the fluid may be thin and almost clear even though loaded with organisms, but more commonly by the time aspiration is initiated frank pus will have formed. When the nature of the fluid and its bacteriological character have been established energetic measures should be undertaken without delay to empty the pleural cavity.

Aspiration

Drainage and aspiration should not be looked upon as separate procedures. Aspiration is the equivalent of intermittent drainage, and if it is carried out properly it is of inestimable value, since it removes pleural fluid by a closed system—that is, one which does not admit air from outside. Unfortunately it is often used perfunctorily and inadequately, with unfortunate results on the course of the empyema.

Thorough aspiration may take a considerable time and must be performed with a needle of adequate size fitted with a two-way tap to a large syringe. The habit of using an ordinary 10-ml. syringe with an ordinary needle is fraught with potential danger because disconnection from the syringe may allow air to seep into the space, and if the empyema is not firmly localized the bubble of air will rise to the top of the chest and allow the lung to fall away from the apex. In other words, a collection of a small amount of fluid in the base of the chest may be turned into a pyopneumothorax with a fluid level and a collapsed lung. A localized empyema is converted into a total pleural infection.

Martin's syringe and needles make a convenient form of apparatus, consisting of a 20-ml. Luer syringe fitted to a two-way tap and with lock fittings to prevent accidental disconnection. A selection of needles is required, and though a wide-bore needle may be needed if the pus is thick a fairly fine needle can be used for a start. The whole apparatus should be tested for patency and for absence of leak before the operation.

The patient sits up in bed and leans over a pile of pillows or a bed table; he may be even more comfortable sitting sideways with the legs over the edge of the bed. A preliminary sedative is an advantage in most cases. The skin is cleaned over the site, which has been previously determined by percussion and radiology, and is usually about four fingerbreadths from the midline posteriorly in the

eighth or ninth space (if the twelfth rib is difficult to palpate it is useful to remember that the scapula lies over the seventh space). A wheal of local analgesic is produced in the skin, and 5-7 ml. of the analgesic is injected into the chest-wall tissues, particularly into the immediately sub-pleural layer. If a wide needle is being used a tiny incision through skin only, made with a tenotomy knife, makes the introduction of the needle easier. Some fluid—for example, local analgesic—should always be present in the aspirating syringe to prevent bursting of the barrel if the piston flies back suddenly on being released.

Aspiration must be as complete as possible, and the operation may take 20 to 30 minutes. If fluid is removed too quickly the patient will feel uncomfortable and develop bouts of coughing, but if the procedure is carried out slowly and, above all, with the needle rigidly still the contents will be evacuated and the lung at the same time encouraged to re-expand. If bacteriology is indefinite, as may well be the case if antibiotics have been used, aspiration must still be performed in just as complete a manner. If, on the other hand, there are active organisms in the fluid an injection of the appropriate antibiotic should follow. Penicillin is the usual agent, and 500,000 units in 10 ml. of saline can be introduced at the end of the aspiration.

The next important step is to ensure that further complete aspirations are carried out as often as any fluid collects; and this does not mean that one should wait three to four days, or even longer, to see what is going to happen. If treatment is to be effective the pleural cavity must be emptied, if necessary, on consecutive days, and aspiration should be abandoned only if the fluid becomes too thick to flow through the needle or, as more commonly happens, flakes of fibrin obstruct the flow. This is probably the most important point in treatment, and one which is often found at the first aspiration. When this occurs it can safely be assumed that the pus is localized, and indeed the thickening of the pleura may be easily obvious on x-ray examination or felt during the passage of the aspirating needle.

Surgical Drainage

When aspiration has become impracticable the decision on the next move depends on the bacteriological findings. If there are still active organisms the abscess should be drained by rib resection at the lowest possible point, accompanied by thorough toilet of the inside of the cavity and wide-tube drainage.

The operation can be carried out under local or general anaesthesia. The patient should be in the sitting position in order to avoid the formidable risk of pus pouring into the lung through an unsuspected broncho-pleural fistula. The lowest point of the cavity is determined by previous aspiration or, in cases of difficulty, after study of two-plane radiographs following injection of 10-15 ml. of radio-opaque oil into the cavity. A vertical skin incision is made. The usual site is the ninth rib, 2 to 4 in. (5 to 10 cm.) from the midline, closer to the spine than might be expected. The rib is stripped of periosteum before removing 2 to 3 in. (5 to 7.5 cm.) of its length, and complete haemostasis obtained before the pleura is opened. A piece of pleura is routinely taken for section to exclude tuberculosis, neoplasm, and so on, and, after the pus and fibrin masses have been removed, the interior of the empyema is inspected and freed from all loose tissue. A wide tube is then inserted: the tube must be placed so as to avoid intercostal vessels and nerves, with its interior opening inside the empyema but not so far as to impinge on lung. Its distal end should not project more than a few millimetres beyond the skin—merely enough, in other words, to hold a safety-pin which, in turn, is attached to the skin by pieces of adhesive plaster. The tube is covered with a simple dressing held in place by a "corset" of strapping, which avoids the discomfort of bulky dressings so common in the past.

The control of drainage tubes is the surgeon's problem, and not one to be left casually to students or nurses. When

a tube is used a number of common errors must be guarded against. In the first place the tube may not be large enough; if the tube is not placed at the bottom of the cavity, drainage will be incomplete. If the tube is changed frequently the contracting skin incision will sooner or later necessitate a smaller tube, and if this happens more than once or twice the drainage opening may become completely inadequate. Many cases of comparatively large chronic empyemas with pin-point sinuses intermittently discharging quantities of pus have been seen in the past. The time for removal of the drainage tube can be summarized by saying that the tube is *never removed from the pleural space but only from a track in the chest wall*. In other words, internal healing must be confirmed by pleurograms (two-plane radiographs taken after filling the space with radio-opaque oil) at 10- to 14-day intervals until the space is finally obliterated.

Breathing Exercises

Even with the most efficient treatment by drugs and surgery the result will be valueless unless at the same time the collapsed lung expands again. The lung must be induced to re-expand, not only to obliterate the empyema space, but to restore pulmonary function. Left to his own inclinations the patient will not move the affected part of the chest more than he can help; the instinct is to immobilize the area. But recovery is complete only when the chest walls are moving freely, and for practical purposes the movement of the chest wall is an index of lung expansion and function. A flattened rigid chest wall is almost certain to conceal an inactive area of lung.

The answer lies in the concentrated application of special breathing exercises which aim at producing a powerful and localized inspiratory excursion over the damaged area. Expiratory exercises, represented by puffing and blowing, should be ignored. The patient is instructed to breathe in deeply and forcibly against the light pressure of the physiotherapist's hand without arching or bowing the spine. After a few days he should be able to concentrate the effort in any part of the chest and he must then practise without fail for 10 to 15 minutes every waking hour, with a check once or twice a day by the physiotherapist. It is the conscientious patient who benefits and reduces his convalescence to a minimum.

The actual exercises are quite simple, but one must repeat that it is persistence and concentration that count. They are begun almost from the day of diagnosis and are continued with increasing intensity until complete recovery results, with the bad side of the chest moving even better than the normal side. The activities of the patient are encouraged by having him ambulant as soon as the grosser signs of toxæmia have been eliminated. The practice of keeping a patient in bed during the whole period of aspiration or drainage is detrimental to early recovery. During the final stages of closure of the empyema patients benefit by active exercise, and many of our patients are walking 8 to 10 miles (12.9 to 16 km.) a day as part of their convalescent treatment.

The Sterile Empyema

A difficult decision on treatment arises when a sterile empyema is encountered. The fluid has been sterilized by the action of penicillin, and the problem is that of a sterile abscess with thick fibrin walls. This poses the question of differentiating this form of empyema from one of tuberculous origin in which, in the absence of acid-fast organisms, a high proportion of lymphocytes in the pus may be the only clue, apart from the clinical history. A sterilized pyogenic abscess usually contains numerous broken-down polymorphonuclear leucocytes, and the shadowy forms of dead bacteria may be seen though bacteriological culture remains sterile. Indeed, a smear film often gives more satisfactory and certainly quicker information in all stages of pleural infection. The fibrin deposit in sterile cases is

even thicker than usual, because with the destruction of bacteria fibrinolytic enzymes are also destroyed. These enzymes are actually manufactured, under the names of "streptokinase" and "streptodornase," and can be introduced with the object of dissolving fibrin. There is a natural reluctance to drain a sterile cavity, with the result that many of these "penicillin empyemas" are left alone, and the thick walls of the persistent cavity prevent healing. Nearly all these cases can be attributed to faulty handling in the form of tardy diagnosis or inadequate aspiration.

In some cases breathing exercises and proper aspiration will start the closure of the cavity, but some do not respond because of the thickness of the contents, as well as the rigidity of the walls, and here two courses of action are open. The cavity can be opened and evacuated through a rib-resection incision, but drainage is not used; instead the skin only is sutured and breathing exercises are intensified. If this fails it is a simple matter to open the skin and insert a drainage tube. The second more radical and severe operation is that of decortication or pleurectomy, which in its best form entails complete excision of the empyema through a thoracotomy incision. The parietal pleura is removed from the chest wall and the lung is freed from its casing. Closed suction drainage and active physiotherapy encourage re-expansion of the lung and obliteration of the dead space. Pleurectomy should not be undertaken for at least six to eight weeks from the onset, and then only if other methods have failed. It can produce excellent results, but it is an operation of some severity and should not be performed if improvement is occurring under more simple measures. Where there is efficient physiotherapy it is not often indicated.

Prognosis

A properly treated empyema of moderate size and severity should be cured in 8 to 10 weeks at the outside. Beyond this period cavity healing is slow and the empyema is well on the way to becoming chronic. A chronic empyema is a formidable disability which may take months to cure, and a useful aphorism to remember is "a week's delay in the early stages means a month's longer convalescence."

Common Causes of Delayed Resolution

There are still many errors in treatment that could be remedied. In the first place diagnosis is not always made early enough, and thoracic surgeons commonly see cases of empyema which are at least a month or six weeks old and which have not been previously treated. Sometimes a collection of fluid that is awkwardly placed may be responsible for the failure to recognize the condition, but usually it is because the lung signs have dominated the picture and the question of pleural infection has been ignored. There may have been failure to start treatment even when the condition has been suspected. Diagnostic aspiration may be put off for a day or so and complete aspiration may be delayed for two or three days while awaiting bacteriological reports and so on. Even when aspiration has been carried out there is sometimes no attempt at any further aspiration, even though the fluid re-collects. Aspiration is often suspended because the pus is sterile. The formal aspiration itself may fail because of faulty apparatus or obstruction of the needle by fibrin flakes. Admission of air is a danger already mentioned. Frequently, once 200 to 300 ml. has been withdrawn, the patient or operator tires and the evacuation of fluid is incomplete. Again, there is too often marked delay between the aspirations and the failure to recognize that complete removal of the fluid will help the re-expansion of the lung. Too much dependence is placed on antibiotics, particularly if these have resolved the infection and signs of toxæmia in the patient. There is also a tendency to delay consultation with the surgeon until some days after aspiration has started to be difficult. There should be complete continuity in the treatment from the

original recognition of fluid until the space is completely and finally obliterated.

There are atypical forms of empyema which are admittedly difficult to diagnose and treat. The discussion has been concerned so far with a limited collection of pus at the bottom of the chest, but the infection can be total or localized to some unusual site. A total empyema requires the most energetic and early treatment if the lung is to re-expand readily, and suction drainage or continuous aspiration can be used with advantage before too much fibrin has been deposited. The lung expands more readily at the base, and may shut off an apical pocket which requires individual treatment. Interlobar collections are more usually placed anteriorly and can easily be missed if good lateral radiographs are omitted. The same applies to pockets placed well above the diaphragm. Mediastinal empyema, which is often mentioned in textbooks, is very rare.

The differentiation between basal empyema and subphrenic abscess, lung abscess, and infected cysts is difficult, particularly if the empyema is complicated by a broncho-pleural fistula. An empyema may heal spontaneously by rupturing through the chest wall or into a lung, but the dangers of the latter range from immediate drowning to chronic pulmonary infection. When empyema is secondary to carcinoma of lung it is possible that it may not heal, and the same applies if a tuberculous infection of the pleura is present. An actinomycotic empyema may heal, but will persist if the lung disease is progressive.

There are few examples in medicine in which early and prompt treatment can pay such dividends as in pleural infection. Antibiotics have reduced its incidence, but diagnosis and treatment have not kept pace, with the result that the spectre of chronic empyema still remains to be finally exorcized.

Next Refresher Course Article.—"The Psychiatric Case and the Law," by Professor Alexander Kennedy.

Nova et Vetera

PIONEERS OF ANAESTHESIA

The English Pioneers of Anaesthesia (Beddoes, Davy, and Hickman). By F. F. Cartwright. (Pp. 338; 20 figures. 21s.) Bristol: John Wright and Sons. 1952.

Dr. Cartwright has told us much of the lives of three men of extremely different mentality, character, and fate. There results a valuable and instructive picture of the conditions of experimental investigation in the late eighteenth and early nineteenth centuries in England, where laboratories hardly existed. In the whole of Britain it was only at Edinburgh and Glasgow that scientific university training was available. Of the three men with whom the book is concerned, only Davy is generally remembered. Beddoes is known to a few, though rather for his associations than for himself, while Hickman is recalled only by a handful of historical specialists. Here Fame must be adjudged to have distributed her favours justly.

From the earliest times attempts have been made to procure unconsciousness during operations by drugs, both ingested and inhaled. "God caused a deep sleep to fall upon Adam, and He took one of his ribs and closed up the flesh thereof" (Genesis ii. 21).

"I'll imitate the pities of old surgeons
To this lost limb, who, ere they show their art,
Cast one asleep, then cut the diseased part."
(Thomas Middleton, *Women Beware Women*, c. 1620.)

Between the dates when these two passages were written, and indeed both before and after, this idea has been in the