THE TREATMENT OF PULMONARY SUPPURATION* INCLUDING ITS SURGICAL RELIEF.

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The achievements of thoracic surgery in the treatment of suppurative diseases of the lungs have recently received considerable prominence and the opportunity will be taken here of reviewing its scope in this field. Probably the majority of such cases seen by the thoracic surgeon recover without operative treatment, but only after a prolonged period of observation.

The conditions we will consider include suppurative pneumonitis, lung abscess and gangrene, infected lung cysts and bronchiectasis. Spontaneous resolution of the first three conditions and complete amelioration of symptoms in the last two—even in the inevitable persistence of gross anatomical deformity—occurs frequently. Accordingly active surgical intervention is withheld until it becomes obvious that either the maximum spontaneous recovery has occurred or that the patient is in the optimum condition for it. So long as a focus of pulmonary suppuration is active, so long is the patient in danger from intoxication, superadded bronchopneumonia or from metastatic intra-cranial sepsis. Similarly, patients with such diseases as bronchiectasis, even when clinically “dry” are always in danger of relapse; the imminence—or what is of more importance for purposes of prognosis, the likelihood—of such a relapse cannot be foretold. Frequently, patients who are regarded as “dry” clinically, are found to be swallowing large amounts of sputum.

Investigation and Preliminary Management.

Investigation is of necessity withheld or delayed in the presence of acute illness. Similarly, for more chronic cases where exhaustion is marked or where the general condition is bad, investigation is modified.

Rest, preferably in the fresh air, and the provision of a diet—adequate in both quantity and quality—are the most important means available by which the general condition may be improved. Massage to the limbs often has an excellent general tonic effect. Vaccines are occasionally employed, but the results are not impressive. Breathing exercises, if carefully supervised by a masseuse fully conversant with their object and limitations, are an excellent means of ensuring efficient pulmonary ventilation; if these are contra-indicated by the general condition, and also as a supplementary measure, frequent inhalations of “carbogen” gas, are similarly useful. Postural drainage, strongly advocated by some, must be employed rationally and with caution; prolonged immobilisation in an inverted position is not tolerated well by patients—some indeed exhibit alarming cerebral symptoms—and it is indisputable that, with the exception of those who are acutely ill, bronchiectatic patients improve most when they are not entirely confined to bed. We prefer intermittent postural drainage and it is our custom to have the patient inverted, or held over the side of the bed with the involved lobe uppermost, for a short period during every waking hour, starting with perhaps one minute and eventually, if tolerated, for as long as five minutes.

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The sputum generally decreases in amount, and becomes less offensive, *pari passu* with the improvement in the general condition. If it does not disappear entirely, its amount usually becomes stationary at a lower level, in which case nothing is to be gained by withholding more active investigations and treatment.

Radiological and bronchoscopic examinations are indispensable at some stage of the investigation of most of these cases. It is our custom, almost without exception, to perform bronchoscopy under general anaesthesia and to utilise the opportunity for obtaining a lipiodol picture of the bronchial tree—bronchography. By these means it is usually possible to determine the nature, extent and situation of the disease with considerable accuracy. A surprising fact which emerges from a large number of these cases thus investigated is the relative rarity of gross obstructive conditions—such as strictures, foreign bodies and growths—as etiological factors in pulmonary sepsis.

Suppurative Pneumonitis.

Occasionally what has been regarded as an ordinary basal pneumonia fails to resolve in the customary manner. The persistence of an area of dullness below and behind, and the occurrence of variations of fremitus conduction—possibly marked diminution, or even absence, at some small spot—lead to the suspicion that an empyema has formed even though breath sounds, rather faint and of the bronchial variety, are heard over the region involved. X-ray examination at first sight would appear to support this suspicion, but the opacity in the film if carefully examined is seen to be not homogenous. This is really due to a patchy consolidation with an associated thickening of the overlying pleura (Fig. 1). So close is the mimicry of the hidden pus—the patient at first may continue to lose ground and have an elevated, or even swinging, temperature, and there may or may not be purulent expectoration—that persistent and misguided attempts to demonstrate pus by needle exploration may be made and an occasional flake of pus is all that is found, but quite a brisk hæmoptysis is not unknown after this procedure. It is a strange belief that such an exploration may determine the onset of recovery. Certainly, recovery sometimes may appear to start thus, but it can only be a coincidence. Meddlesome explorations in these cases cannot be too strongly deprecated, so great is the danger of causing air embolism or brain abscess by inserting needles promiscuously into lung tissue.

Expectant treatment, if necessary for a prolonged period, is usually rewarded by complete recovery, and it should be persisted in for as long as the patient continues to improve. Obviously if ground is being lost, or if the condition becomes stationary and resembles bronchiectasis, then operative treatment will be required.

Exposure of the diseased lobe may be necessary and, if the mechanical problems involved are not too great, it may be removed. If the patient is too feeble or ill, or if the lobe is too adherent to permit of its removal without undue risk, then adequate drainage may be provided by burning extensively into it with the cautery.

Lung Abscess and Gangrene.

These conditions are so closely allied that it is often difficult to distinguish one from the other. What may appear at first to be a localised abscess condition may ultimately prove to be a diffuse gangrene. There are, of course, fulminating cases in which the frankly gangrenous nature of the disease is obvious from the beginning. Similarly, there are cases in which, despite an apparently

FIG. 1 :—Suppurative pneumonitis. A typical example of delayed resolution of a basal “ pneumonia,” involving the lower part of the right lung : (a) condition three weeks after a supposed crisis, pyrexia having recurred ; (b) condition one month later, process resolving.

FIG. 2 :—Lung abscess. An enormous cavity with a “ fluid level” occupies the greater part of the left lung. A large amount of sputum resembling anchovy sauce was expectorated for about six weeks prior to operation, when the presence of this cavity *within* the lung was confirmed. Complete recovery followed drainage.

FIG. 3 :—Lung abscess. A cavity is seen in the lower part of the right lung ; it has a thick wall, indicating a fibrous tissue reaction around it, and a “ fluid level.” Recovery followed drainage, but a minute bronchial fistula persists without causing any disability.

FIG. 4 :—Lung cyst. A cavity, with a fluid level, about the size of a tangerine, is seen in the lower part of the right lung. During several years, supposed empyemata in connection with this cyst, had been drained. The cyst was dissected out of the lung and the cavity later closed by a plastic operation. The sputum, previously profuse, disappeared and the general health improved markedly.

FIG. 5 :—Bronchiectasis. The lower lobe of the left lung has large dilated bronchi ; these are demonstrated by lipiodol. A typical case, in which lobectomy has since been performed.

FIG. 6 :—Bronchiectasis. The bronchi of the entire left lung, having been outlined by lipiodol, are seen to be enormously dilated. The condition is probably one of congenital multicystic lung. The patient has survived removal of the whole of the left lung.

severe onset, a well localised abscess ultimately forms. These diseases may occur as complications of pre-existing pulmonary inflammations, such as pneumonia or bronchiectasis. They may follow dental or other operations upon the upper respiratory tract, or as delayed complications of thoracic or abdominal infections, in a similar way to suppurative parotitis.

Abscess formation may follow impaction of foreign bodies aspirated into the bronchi, in the presence of infection. Most abscesses, however, even those following dental extractions, develop without any such obvious cause, recognisable either radiologically or bronchoscopically. It is possible that in many instances the infection is blood borne, causing septic infarction.

Both abscess and gangrene are occasionally associated with pulmonary growths. Infection of the secretion pent up in a bronchus behind a growth gives rise to an abscess, the symptoms of which may predominate and completely mask the presence of the growth, which may only be discovered during routine investigation or even during an exploratory operation. Colliquative necrosis within a growth may simulate an abscess, especially in an X-ray picture. Pulmonary growths may be complicated terminally by the sudden onset of a diffuse and fatal gangrene.

Whether the process is to proceed ultimately to abscess or gangrene the initial change is probably identical, being one of tissue necrosis. This proceeds to liquefaction, and a cavity develops. If the condition is to become a localised abscess, a zone of granulations, replaced later by fibrous tissue forms around it. If this defensive reaction fails to eventuate, then the lung becomes diffusely gangrenous.

The onset, which is usually sudden, may be ushered in with a rigor. Coughing and pain in the chest are sometimes marked symptoms; a sudden attack of pain accompanied by a slight hæmoptysis may indicate that, in an individual case, the initial process is one of infarction.

Foul purulent sputum is freely expectorated and in the early stages, or so long as destruction of the lung substance continues, the sputum has a curious dark appearance resembling anchovy sauce. When, however, destruction gives place to inflammation, the sputum becomes more frankly purulent and as healing occurs it diminishes in amount.

During the earlier stages wasting is marked and rapid and the accompanying cachexia causes a definite anæmia. Fever is usually high for some time, but later becomes lower; when the abscess settles down into a state of chronicity the temperature is likely to be normal. Rarely and in some of the more fulminating cases of gangrene there may be no marked elevation of the temperature.

The X-ray appearances of a pulmonary abscess are at first indistinguishable from those of gangrene, a marked "fluffiness" being seen in the affected part. Later, as the lung tissue breaks down and liquefies, a cavity, in which there may be a fluid level, becomes apparent. (Fig. 2). The development of fibrosis around the cavity results in a definitely recognisable thickening of its wall. (Fig. 3).

Conservative or expectant treatment, on the lines already described, is tried in all cases; for many it suffices, but others require the help of surgery. Surgical treatment is withheld as long as possible, not only because many cases will recover spontaneously, but because premature interference, before an abscess has become stabilized and well encapsulated, is known from experience to lead to disaster.

Artificial pneumothorax has been recommended in the treatment of abscesses, but the danger of infecting the pleura is too great unless the abscess is situated close to the hilus; if the induction needle should prick an infected portion of the lung or if a cavity in the lung should burst into the pleura, then a serious empyema would certainly occur.

Once there is definite evidence of encapsulation—usually after a lapse of at least four to six weeks—and it is obvious that spontaneous resolution is unlikely, then steps must be taken to drain the abscess externally. Under suitable anaesthesia portions of two or three ribs are removed from the vicinity of the underlying abscess, which has been previously carefully localised. These rib resections entail some diminution in the convexity of the chest wall and so facilitate the subsequent obliteration of the abscess cavity by cicatrisation. If it is ascertained that the lung is adherent to the chest wall, the abscess is opened by burning through the intervening lung tissue with the cautery which minimises hæmorrhage and the risk of air embolism. If the pleural cavity is patent, the parietal pleura is carefully stripped by blunt dissection from the chest wall and a mass of paraffin wax placed in the resulting space, thus maintaining the parietal and visceral layers of pleura in contact, and so encouraging their cohesion.

Two or three weeks later, when the two layers of the pleura have become adherent, the wound is reopened, the wax removed, and the abscess drained in the manner described. Occasionally, during this interval either of two events may happen. The wax may act by compressing the abscess and cause it to burst either into the bronchus, when its contents are coughed up and spontaneous recovery follows, or it may burst into the bed of the wax and so through the incision on to the surface. In the latter case the wax is removed and adequate drainage is automatically established.

Lobectomy has been recommended for lung abscess, but the writer has no experience of the operation in this connection.

Lung gangrene is a very fatal disease for which little can be done. If the pleural cavity is obliterated by adhesions then the necrotic lung may be widely exposed and sequestration hoped for. A few such cases recover, but even if the patient survives the intense toxæmia there is great risk of death from hæmorrhage when the sloughs separate. When the pleural cavity is free from adhesions, the possibility of rapidly applying a ligature to the hilus and amputating the necrotic lobe beyond it should be borne in mind.

Solitary cysts, of developmental origin, lined by epithelium resembling that lining the bronchi, occur occasionally in the lungs. They may remain undetected until comparatively late in life. Following infections of the bronchi, infection is likely to persist in such cysts because as a rule they are inadequately drained. If the cyst communicates freely with a bronchus the continued expectoration of purulent sputum may lead to a diagnosis of bronchiectasis, with which the condition is occasionally associated, and the true nature of the condition only recognised after routine radiological investigations. If the bronchial communication is occluded or inadequate the pent up purulent secretion may perforate into, and infect, the pleural cavity; many cases first come to the notice of the thoracic surgeon as empyemata which continue to discharge or re-accumulate (Fig. 4). Unless the mucoid secretion from the bronchial epithelium is noticed or the cyst recognised radiologically—in this connection the necessity for repeated radiological examinations to detect a fugitive “fluid” level must be mentioned—the cyst is unlikely to

be detected except by an exploratory operation. Some of these cysts near an accessible surface of the lung may be dissected away satisfactorily, or the lining destroyed by cautery and the cavity obliterated by a plastic operation. In other cases it may be necessary to extirpate the portion of the lung containing them. If the general condition or the local technical difficulties contraindicate such radical treatment it may be necessary to be content with establishing adequate drainage by means of a permanent external fistula or sinus.

Bronchiectasis.

The etiology and pathology of bronchiectasis is very imperfectly understood, and a great deal of confusion exists in the literature on the subject. Although denied by many pathologists, it seems reasonably clear on clinical grounds, that many cases are of congenital origin, especially those characterised by saccular dilatations or large cystic cavities. (Fig. 6). These are closely related to the solitary bronchogenic cysts encountered in the mediastinum and in the lungs. Other cases are associated with pulmonary collapse, but it is not clear whether the collapse or the bronchiectatic change is primary as the evidence is ambiguous. Occasionally only the lower lobe of a lung may be collapsed, yet both lobes may be equally bronchiectatic, and there is, on the other hand, positive evidence that bronchial dilatation may occur subsequently to collapse. Weakening of the bronchial wall following inflammations associated with the acute exanthemata, pneumonias and even empyemata are all regarded as of etiological significance.

Whatever the type, bronchiectasis is characterised clinically by intermissions, the cases being alternately "wet" and ill or "dry" and relatively well for varying periods. Some cases, especially the congenital cystic variety, may be free from symptoms and consequently undetected until some superadded infection, occasionally late in life, occurs; others run a course which is, on the whole, predominantly "wet". Once a case has been "wet" recurrence is likely and sooner or later these cases succumb to toxæmia, spreading suppurative pneumonitis, cerebral abscess, or meningitis. There are no criteria by which it is possible to select those cases which are likely to do well from those which are likely to do badly and experience suggests that extirpation offers the only prospect of cure for the victims of this disease and the best prospect of prolonged survival. Those who recover from the operation are, almost without exception, completely relieved.

Unilateral cases, naturally, were amongst those for which extirpation was first employed. The operation of lobectomy is now commonly practised for disease involving one lower lobe (Fig. 5) and, whereas the mortality of the operation a decade ago was as high as sixty per cent., it is now probably in the vicinity of twenty per cent. Sauerbruch has recorded a series of 58 cases with a mortality of only ten per cent. "Dry" cases withstand the operation best of all and every possible means is adopted to ensure that sputum production is minimal at the time of operation. Children stand the operation remarkably well, and in the writer's series of eighteen cases under the age of 13 years treated by operation, in which a lower lobe was extirpated for bronchiectasis, only two cases died; one from undetected coincidental acute infection and the other from adherent pericarditis three months afterwards. The youngest survivor was aged 3 years and 11 months at the time of operation. Early adult life seems to be a relatively dangerous age at which to undergo the operation, but this is a point presumably upon which further light will be thrown by increased experience. The writer has removed the whole lung for bronchiectasis involving the entire organ in seven

cases, in five with success. In one of the two fatal cases a technique, now probably discarded, was employed and in the other an injury to the vagus nerve, now probably avoidable, occurred. These results, and the experience of others, demonstrate that these operations are of great therapeutic value. It should be pointed out to the patients that for technical reasons it may be necessary to operate in stages.

Bilateral cases call for more serious consideration; patients have survived after removal of both lower lobes, hence when the disease is limited thereto cure is possible. In such cases, and even when the disease is more widespread, clinical, bronchoscopic and other forms of observation, frequently indicate that one lobe is predominantly affected and its removal may give very marked relief.

Artificial pneumothorax, extra-pleural plugging with tampons or with paraffin wax, and thoracoplasty are all forms of collapse therapy which may be required on occasion to alleviate symptoms, but they are uncertain in their results and are never curative measures. They are of most use as a preliminary to extirpation, or as a palliative operation where resection is unsuitable because of age, generalised disease, or other factors.

In congenital multicystic disease, the secondary inflammatory changes, as seen macroscopically, are frequently limited to the lower lobe, and often to its lower portion, presumably because once infection is established it persists in the relatively inadequately drained lower lobe. Lower lobectomy in such cases may give complete symptomatic relief despite the presence of the cystic condition in the remaining upper lobe. An empyema sometimes, and a mediastinal abscess more rarely, may complicate bronchiectasis; they are satisfactorily treated by drainage in the usual manner. A previous history of an empyema is no contra-indication to a proposed lobectomy or pneumonectomy; the adhesions encountered in such cases, although diffuse, are usually easily separable.

Conclusion.

Every case of pulmonary suppuration requires consideration on its own merits. There will be difficulty in fitting many cases *exactly* into one of the categories described here; indeed in actual practice it will be found that all these conditions are so closely related to one another that it is well nigh impossible to differentiate between some of them. It is important to realise that, although the scope of thoracic surgery has increased enormously of late, surgical measures are only employed when it becomes obvious that further or complete recovery is unlikely without such help. Even so, operation is usually not undertaken until the individual problem has been fully considered by both the surgeon and the physician concerned.

The opportunity is taken to urge practitioners to investigate completely any case in which there is prolonged cough or abnormal expectoration, especially when such resist the ordinary remedies. In the limited space available it has not been possible to do more than outline briefly the more important facts of the subject, but it is hoped that enough has been said to be of assistance to those who are called upon to manage such cases. Many a case hitherto regarded as a hopeless "chronic" has, after investigation by the methods now available and an appropriate operation, been restored to active, and often normal, life.