When found dead—and numbers have been so found—their bodies are enormously distended. The only real objection that can be levelled against the virus is that rats dying of the infection have the awkward habit of breathing their last under the floors of dwelling-houses. The resulting stench is at once followed by complaint to the Public Health Department, but we have kept silent as to the cause of death.

Poisons such as phosphorus paste are good in their way, but other animals may reach the phosphorus. Rats are extremely cunning too. They may partake of the phosphorus to-night, but the experiences of the burning sensation created in their throats must be told to other rats, for phosphorus paste is for a considerable period left severely alone.

Most rat-catchers are a delusion. They may produce a few live specimens during the course of a week, but that is all. In Leith two rat-catchers were employed for three weeks, and the number of rats they caught was trifling. They can tell one where rats may be found, but that is all.

THE SURGICAL TREATMENT OF EMPYEMA.

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(Plate VIII.)

With diffidence, though without apology, I venture to publish this essay, that from the consideration of one hundred consecutive cases of empyema, I may advocate the partial removal of one or more ribs as the routine treatment. For comparison it is necessary to have a series of cases of the same disease treated otherwise. I regret that I have been unable to collect cases equal to my own in number, but I have gathered what I could by the perusal of the records in the Dundee Royal Infirmary during the eleven years 1880 to 1890 inclusive. During that period twenty-nine cases only were submitted to surgical treatment, whereas my hundred cases occurred within seven years. This apparently increased prevalence, I have no doubt, is to be explained chiefly by the greater ability of the general medical practitioner in later years to recognise the condition, and to his appreciation of the advantages of early surgical treatment. In the twenty-nine cases the treatment consisted of—(1) Aspiration, (2) aspiration followed by incision, and (3) incision; and in my cases the treatment consisted of partial removal of ribs. Other points of difference will appear in the course of this paper, but in the meantime a general comparison of these methods of treatment are embodied in the following table:
This table places the treatment by excision of ribs in the worst possible light, because in my cases all varieties of empyema are included, whereas in those I have used for comparison neither tuberculous nor chronic cases are found. It would be productive of very false conclusions were all varieties of empyema to be massed together, and, whatever other divisions may be considered justifiable, it is certain that a distinction should be drawn between chronic and acute empyema. This necessitates a definition of "chronic empyema," and this I would give as "an empyema where the pleura is so thickened as to require removal at the operation." One would be justified in subdividing each group according to the presence or absence of tuberculous disease of the lung. This subdivision I do not intend to adopt. Amongst my cases, 4 per cent. were examples of chronic empyema, and these I will reserve to separate consideration, except in sex, age, side affected, and preceding disease, which the chronicity of the illness cannot affect.

It is conceivable that the proportion between the sexes may vary in different localities according to the extent to which women are employed and the nature of the work. By examining the records of one hundred and thirteen consecutive cases admitted to the Dundee Royal Infirmary, I find that the proportion of women affected is slightly over 33 per cent., whereas in my hundred cases the proportion was 75 males to 25 females. The relation between sex and age is shown thus:

| Under 5 years of age | Males. | Females. | Total. |
|----------------------|--------|----------|--------|
| Between 6 and 10 years|        |          |        |
| " 11 " 20 "          | 20     | 13       | 33     |
| " 21 " 30 "          | 14     | 5        | 19     |
| " 31 " 40 "          | 10     | 2        | 12     |
| " 41 " 50 "          | 19     | 3        | 22     |
| " 51 " 60 "          | 8      | 1        | 9      |
| " 61 " 70 "          | 3      | 0        | 3      |
|                      | 1      | 0        | 1      |
|                      |        | 1        | 1      |
|                      | 75     | 25       | 100    |
The sexes are more equally affected at either end of life—at the commencement, when the clothing, habits, and environment, are practically the same, and in life’s later days when the exposure is again very similar.

The right side was affected in fifty-two persons, the left in forty-five, and in three children the affection was bilateral. This accords with other observations, that the sides are affected with equal frequency. I also find that the mortality is greater in left than in right empyema (almost 2 to 1 in my cases).

Empyema is a sequel to some inflammation, and it is obvious that the prognosis must be affected by the nature and duration of the previous disease, and this again by the patient’s constitutional tendencies. On the one hand, out of twenty-four fatal cases 29 per cent. had a distinct family history of tuberculous disease; and, on the other hand, out of seventy-two successful cases 13 per cent. had a distinct hereditary disposition to tuberculous disease, though a more thorough investigation might have raised the number in both divisions. The details of the illness preceding the empyema may be tabulated thus:

| Condition                                | Number | Deaths |
|------------------------------------------|--------|--------|
| Pneumonia                                | 51     | 8      |
| Pleurisy                                  | 17     | 2      |
| Phthisis                                  | 6      | 5      |
| Pneumonia during enteric                  |        |        |
| Broncho-pneumonia                         |        | 1      |
| Broncho-pneumonia with measles            |        | 1      |
| Influenza                                 |        | 1      |
| Scarlet fever                             |        | 1      |
| Pneumothorax                              |        | 1      |
| Foreign body in the oesophagus            | 1      | 1      |
| Septicaemia                               |        | 1      |
| Vomiting and diarrhoea                    |        | 1      |

In sixteen cases the previous illness is not recorded.

It seems a justifiable deduction that the longer it has existed the less likely is an empyema to close early; and though it is rarely possible to say the exact day on which an empyema began, such knowledge may be approached by considering the duration of the previous illness. The more acute the illness the less will be the possibility of error. In four, phthisis was the disease which preceded the empyema, its average duration in these patients being 285 days; and though empyema had developed during the latter part of the illness, it was not possible to say when it had come on.

The cause of death in twenty-four cases is shown in the following table:

| Cause                        | Number |
|------------------------------|--------|
| Phthisis                     | 6      |
| General tuberculosis         | 1      |
| Tuberculous meningitis       | 1      |
In five out of six fatal cases of empyema preceded by pneumonia, the average duration of the illness before operation was eighteen days; while in forty successful cases preceded by pneumonia the average duration was twenty-six days; which perhaps shows that the further the patient has passed through the attack of pneumonia before requiring operation, the better the chance of success. The case of general tuberculosis was that of a child who had been ill with pleurisy with effusion for twenty-seven days before operation, and died twenty-seven days later. In a child of 20 months old, measles and broncho-pneumonia had existed for thirty-five days before the empyema was operated on. He did not do well, and thirty-five days after operation he was removed home, where he died twenty-seven days later, presumably from septicaemia.

One of the cases of cardiac failure was that of a young man, aged 20, who, after an illness of 120 days, arrived home from abroad said to be suffering from phthisis. No evidence of phthisis was found, but there was a right pyo-pneumothorax communicating with a bronchus, and though the operation only occupied a few minutes, death followed just after his return to bed.

One of the cases of septicaemia was a boy who developed a septic empyema from an infected wound in the neck made during the removal of tuberculous glands; and another was a child in whom at post-mortem examination a halfpenny was found, which had caused a perforating ulcer of the oesophagus.

Before passing to consider the operation and the factors which influence it, and before examining the cases and groups in further detail, I think it will conduce to the interest of the paper to state the results in tabular form.

| Condition                                | Number | Percentage |
|-----------------------------------------|--------|------------|
| Gangrene of lung (phthisis?)            | 1      |            |
| Shock                                   | 5      |            |
| Septicaemia                             | 3      |            |
| Cardiac failure                         | 2      |            |
| Endocarditis                            | 1      |            |
| Pericarditis                            | 1      |            |
| Nephratitis with uraemia                | 1      |            |
| Diarrhoea                               | 1      |            |
| Not ascertained                         | 1      |            |
|                                      |        | 56 per cent. |

In the treatment of empyema the points to be aimed at are—
(1) Safety; (2) rapidity; (3) evacuation of contents of empyema; (4) earliest possible obliteration of the cavity.
It is not advisable to discuss the operation under these heads separately, because they overlap, but simply to retain them as general guides. Of first importance is the question of the anaesthesia and the anaesthetic, for there is a widespread belief that this is specially dangerous. In all my cases the anaesthesia has been general and the anaesthetic chloroform. Local anaesthesia may be suitable in certain cases, though I would not advise it for a more extensive operation than simple incision, or at most removal of part of one rib. Ether appears to me to be too irritating to have preference, but I can quite imagine a feeble patient who would benefit by the administration of A.C.E. mixture. One claiming authority has recently stated that the action of A.C.E. is that of chloroform alone. To this I cannot agree, and I do not think that anyone could overlook, what a very small experience will show, that where under chloroform there is a tendency to deficient respiration and cardiac feebleness, the substitution of A.C.E. mixture is followed by improvement in pulse, respiration, and colour. If the patient be very weak, I give a little strychnine with or without digitaline hypodermically before operation, but I do not make a practice of it. It is specially desirable that in empyema the patient should have confidence in the anaesthetist, because excitement and fear are closely allied, and the latter I am convinced plays no small part in causing cardiac failure, particularly in children. The anaesthesia must be as short as possible, and therefore everything must be ready for the operation before the administration of the anaesthetic is commenced. The patient should not in any way be moved during or after the production of anaesthesia, because it causes movement in the fluid in the chest, and consequent alterations of intrathoracic pressure on viscera, nerves, or blood vessels, which may increase defective breathing or impeded action of the heart. It is imperative that the anaesthetic be given slowly and gradually, any choking, gasping for breath, or coughing being dangerous in proportion to the depth of the anaesthesia.

The patient lies on his back. Of course where the empyema is there the operation must be, but I am not dealing with localised empyema, and the physical conditions which obtain in the case of a large quantity of fluid do not exist with a small collection. As the patient becomes unconscious, the arm on the affected side is raised till the hand can be placed behind the head, and there it is steadied by an assistant or fixed with a bandage. The skin is rapidly cleaned with aetherial soap washed off with 1 per cent. lysol solution. I prefer to have a moist carbolic dressing on the side overnight or on the morning of the operation in adults, but would not delay the operation to obtain this. As soon as anaesthesia is sufficient, the anaesthetic is stopped, and the operation in an ordinary case can be completed without administering any more.

The incision I make in the middle, anterior, or posterior axillary
line, according to where the dulness reaches in the recumbent position. It is made at right angles to the long axis of the ribs, and is carried down to the bones at once, dividing some fibres of the serratus magnus muscle in its course. Though there may be a little bleeding from the long thoracic vein or some of its branches, it is seldom necessary to stop to catch the bleeding points, for the haemorrhage will cease when the chest is opened and the congestion relieved. With the left hand the wound is held open and the chest steadied, while the knife is drawn along one of the ribs to incise its periosteum. The knife is now laid aside and with an elevator the periosteum is raised from the bone, first from its outer side, then from its margins, and lastly from the inner surface. This done, the limb of a curved bone forceps is passed under the rib guided by the periosteum elevator, which is not till then withdrawn, and the rib is cut through behind. The free end of the rib is now raised by the left hand and the curved bone forceps again introduced, and the rib divided in front as far forward as necessary. This is repeated with as many ribs as it is desired to remove. The periosteum elevator is then thrust through the pleura and the pleura torn open by the fingers. The hand is then used to explore the size, site, and shape of the cavity, the thickness of the pleura and the condition of the lung. The cavity is emptied, swabbing or douching being employed if necessary. A broad piece of gauze is hung over the posterior lip of the incision through the whole of the extent, and the wound dressed with salicylic wool and a bandage applied. In a straightforward case, with an anaesthetist who knows his business, the operation from the commencement of the administration of the anaesthetic to the completion of the bandaging should take only a few minutes. This rapidity is desirable, because it causes a minimum shock, relieves the respiration and circulation as soon as possible, and puts an end as early as possible to the anaesthesia.

One of the first questions which rises in connection with the operation is: Should one wash out the cavity? It seems to me the indications are clear. The contents of the cavity are to be removed, and if the easiest way to do that is by washing, then wash. One has to be guided, too, by the condition of the pus. We may specify the varieties of pus found in empyema as:

(a) Fœtid.
(b) Non-fœtid.

(1) Thin.
(2) Thick.
(3) Coagulated.

Fœtor is a serious item in the prognosis. Of my cases 10 per cent. were fœtid, of which 8 per cent. occurred among the successful cases and 12 per cent. among the fatal cases. In two out of three fatal cases the patients died of gangrene of the lung, one on
the ninth and one on the eleventh day after the operation. In fetid cases I recommend not only washing at the operation, but daily washing till the factor has disappeared. The majority of empyemata are due to infection by the pneumococcus, and it is a well-known fact that all effusions due to this organism show extraordinary tendency to coagulate and form fibrous exudation whether in the pleura, the peritoneum, in the joints or elsewhere. In empyema from such a cause coagula are to be expected, and about 60 per cent. of empyemata are due to pneumococcus infection alone. Through a simple incision or by aspiration, these masses cannot be removed, and if the cavity is to be emptied a correspondingly large opening must be made. Washing helps the removal of these coagula, though if a large enough opening be made the hand can be introduced and the coagula lifted out.

The principal point in connection with washing out the cavity is that the opening must be large enough to allow the fluid to flow out as rapidly as it is introduced, so that no undue intra-thoracic pressure may be brought about. I wash out the cavity by pressing in the anterior lip of the incision with four fingers while lotion is poured freely in from a jug, and there is nothing to hinder it running out freely. The temperature of the lotion varies, but is generally about 105°; but if the patient is collapsed, hot lotion may be used, and is followed by improvement in pulse and respiration, as occurs in washing out the peritoneum.

The uselessness of special drainage tubes is proved by their multiplicity. I use none, a free opening obviates the necessity, and I believe a drainage tube may prevent the approximation of the parietal and visceral pleura.

The closure of the cavity depends on—

(1) The expansion of the lung; (2) the ascent of the diaphragm; (3) the falling in of the chest wall; (4) the return of the displaced heart in a left empyema.

The extent to which each of these participates varies with the size, site, and age of the empyema. In a small empyema, none of these factors may be required except the expansion of the lung, and a recent empyema anywhere may be obliterated by the expansion of the lung alone. An empyema may be in any part. It may be between the lobes of the lung, simulating a true pulmonary abscess; it may be between the lung and the diaphragm, or in any part between the lung and the chest wall. Previous adhesions may limit the empyema, and I am not sure that consolidation of a lobe may not direct the effusion to some other part. It is my opinion that apex-reaching empyemata are more common than is generally believed. There is still a general tendency to look for an empyema at the “most dependent part of the chest.” Anatomically, in the supine subject, the most dependent part of the chest is posteriorly about the level of the ninth rib, below the angle of the scapula. This would be constant, did
patients always lie supine; but, apart from former adhesions and present consolidations, the most dependent part of the pleural cavity varies with the position of the patient. Age interferes with the factors which close the cavity, because the older the empyema the thicker the pleura, and the thicker the visceral pleura the more is the expansion of the lung interfered with. This thickening may also prevent the falling in of the chest wall even after removal of ribs. The recognition of this constitutes the difference between Estlander's and Schede's operations, and the interference with the expansion of the lung explains the utility of decortication. That the lung expands after decortication, when the thickened visceral pleura has been peeled off, proves that long compression of the lung does not end in alteration of the lung tissue unless in the presence of phthisis.

To the absence of changes in the pleura and lung tissue the expansion of the lung after thoracotomy bears an inverse ratio, and it must not be forgotten that between the lower border of the lung and the lower limit of the pleural sac there is a distance of two to four inches which the lung never reaches, and which consequently can only be obliterated by adhesion between the diaphragmatic and parietal pleura.

The vault of the diaphragm reaches during expiration as high as the level of the sixth rib or a little higher, and, with a little falling in of the chest wall to counteract the flattening of the cupola, the diaphragm is capable in itself of obliterating the cavity to that extent. The importance of this, from a surgeon's point of view, is that the contact between the diaphragm and the chest wall to the level of the sixth rib must not be interfered with, and that the insertion of drainage tubes below this level tend to the formation of a long sinus leading up to an obliterating cavity. The amount of falling in of the chest wall depends on the resiliency of the ribs, and where this is wanting, as in old people, it depends entirely on the amount of ribs removed. In the case of children and young adults, where the empyema is not chronic, the expansion of the lung is the main factor in the obliteration of the cavity; in cases of longer duration, this is assisted materially by the ascent of the diaphragm. In chronic cases, and in persons past young adult life, removal of ribs is necessary.

In my own cases, the site of the incision varied as follows:—

1. In the anterior axillary line, nine times; 2. in the mid-axillary line, fifty-seven times; 3. in the posterior axillary line, six times; 4. in front of the anterior axillary line, once.

The ribs removed were preferably the fourth to sixth inclusive, but, if circumstances warranted, additional ones above and below were resected. The numbers of ribs partially resected in seventy-two cases were—

1. In one case no ribs were primarily removed, because the
physical condition of the child did not warrant more than incision—five ribs were subsequently removed; (2) in one case one rib was resected; (3) in twenty-one cases two ribs were resected; (4) in thirty-five cases three ribs were resected; (5) in eleven cases four ribs were resected; (6) in three cases five ribs were resected.

For this method of operating, as a routine, I claim the following advantages:

(1) Safety during operation; (2) rapidity and ease of procedure; (3) thorough evacuation of contents made certain; (4) safety and ease in lavage; (5) facility in subsequent dressings, the patient never having to sit up nor turn on the side; (6) thorough inspection of cavity and contents; (7) satisfactory drainage.

Against these, all of which no other operation can claim to fulfil, there is the only objection of greater shock to the patient. Therefore, admitting the superiority of a free opening with resection of ribs, incision would still be the proper treatment in patients who were much enfeebled from duration or severity of illness.

Incision alone leads to many secondary operations, because the wound closes before the cavity; and even in the extensive

Fig. 1. Fig. 2.

operation I advocate, second operations are found necessary, though less frequently than where incision alone is adopted. A second operation may be necessary for enlargement of the sinus, or for removal of sequestra. This was required in eight out of ninety-six cases—twice for removal of sequestra, and six times for delayed closure of the sinus. Excluding four chronic cases, a second operation was called for in one out of every twelve of my cases; whereas, among those treated by incision without division of ribs, which I have collected, a second operation was done in one out of every three and a half cases. Where a second operation was required for the removal of sequestra, it was in one case done on the 129th day, and in the other on the 280th day, after the primary operation. These sequestra (Fig. 1) are elongated, irregularly shaped pieces of bone, not unlike misshapen rib, and I have no doubt are formed from loose hanging pieces of periosteum. In my experience, small pieces of bone, of extreme irregularity (Fig. 2), are always to be found around the sinus during second operations. From their shape and size, it is evident
that they are not pieces of rib fractured at the operation, and, being clothed in periosteum, are not necrosed. Their presence seems to interfere mechanically with the closure of the sinus on rare occasions.

Secondary operation consists in the removal of the sinus and the ends of the cut ribs about it, and if necessary one or more contiguous ribs. In my six cases, the number of days which elapsed between the primary and the secondary operations was 72, 87, 22, 163, 48, and 80. The operations may be summarised thus:

1. Sinus excised, one case;
2. Sinus and one rib above excised, one case;
3. Sinus and one rib above and one below excised, one case;
4. Sinus and two ribs above and one below excised, one case;
5. Sinus and two ribs above and three below excised, one case;
6. Sinus with two ribs above excised, one case.

This shows that though I make my incision higher up than is usually taught, yet, in cases where the healing was delayed, I had to remove more ribs from above than from below to get the cavity closed.

In only one case was a third operation required. This compares favourably with cases treated by incision alone, where 1 in 8 required a third operation. What is there to account for the delay in closing, for it is on that account that second or third operations become necessary? I believe the chief factor to be the duration of the empyema before operation. Two of my cases had been ill only twenty-eight days before operation. One of these patients had a foetid empyema, and the other was a boy, at 14, in whom I underestimated the collapse of the chest wall which would be required, the lung and diaphragm taking less share in the closure of the cavity than I expected. A third case had been ill forty-five days with a foetid pyo-pneumothorax. Another had been ill forty-nine days, and had albuminuria, from which he gradually recovered after the thoracoplasty. The remaining two patients in whom closure was delayed had been ill fifty-six and sixty-four days respectively. It is apparent that every one of these has some feature to place it without the pale of promising cases. It is to be expected that foetid empyemata take longer to heal than cases in which factor is absent, for the illness is much more severe and the constitutional disturbance more serious. In the above cases of delayed closure, three out of six were foetid. Rickets, tuberculosis, inherited syphilis, an unusually severe or prolonged illness, the presence of some debilitating affection such as albuminuria, or the development of an intercurrent disease, tends to interfere with the straightforward healing of the case. Perhaps, with greater numbers, second operations might be found to be more frequent in adults than in children, but my cases are too few to warrant a deduction on this point. The ages in the six cases were 3, 14, 28, 28, 30, and 42 years. Allied to delayed
closure are those cases which had a sinus when last heard of. Amongst my cases they numbered nineteen. Two children were removed from hospital by their relatives against advice on the fourteenth and ninth day of residence. A patient who was “transferred to another hospital” was a man, æt. 22, who came under my care in Standerton, Transvaal, during the South African War. He had a left empyema twelve days after pneumonia, and was doing well on the thirty-second day after operation, when he had to be transferred, as we were changing camp. I have no doubt that this man ultimately healed, and I regret I am compelled to include him in this part of my statistics. A similar regret exists in relation to two patients discharged “almost healed” in whom the wound was superficial, and I have no doubt that had the wound not rapidly skinned over they would have returned for advice. As it is, I have been unable to trace either. In addition to these, fourteen patients were discharged with the wound not healed; that is to say, of empyemata treated without interference from patients or friends, 16 per cent. were discharged with a sinus. It is highly probable that these cases ultimately did well. With one exception, they were discharged because they were doing well, were almost healed, and there was no apparent reason why they should not continue to do well. There is often a temptation to send such cases home not quite healed to make room for other patients in hospital, and this is more justifiable than formerly, since patients of this class can obtain the services of the district nurses if unable to attend the out-patient department of the hospital. The average duration of the illness before operation in these fourteen cases was forty-two days, being twenty days longer than the duration of the illness in those cases which healed without delay, and five days longer than in those cases where a second operation was required.

In only one of these cases with persistent sinus was a second operation performed. It was that of a patient, æt. 10, who after a twenty-eight days’ illness was operated on for a foetid left empyema, and portions of the seventh, eighth, ninth, and tenth ribs removed through an incision in the posterior axillary line. Seventy-two days later the sinus and the ends of the surrounding ribs, with portions of the fifth and sixth ribs, were removed. The prolongation of this case may be ascribed to the foetid condition of the empyema, and to the operation having been performed too low down the thorax. As other typical examples of cases which heal slowly and are apt to end in sinuses, I give these four:—

Case 1.—A child, æt. 2 years, had been ill with a right empyema for seventy days before parts of the fifth, sixth, seventh, and eighth ribs were removed in the anterior axillary line. After a residence of twenty-nine days in hospital, she was discharged not doing well, the cachectic condition into which the child had passed before operation still existing.
She returned, however, seven months later, in good health and with the sinus almost closed.

Case 2.—A boy, æt. 8 years, had been ill for ninety days before operation. The fifth, sixth, seventh, and eighth ribs were resected in the anterior axillary line for a right empyema. He was in hospital for one hundred and seven days, and was known to have a sinus two and a half years later. The prolonged illness before operation was the probable cause of the slow progress.

Case 3.—A young man, æt. 22, was operated on forty-two days after the commencement of his illness. Parts of the fourth, fifth, sixth, seventh, and eighth ribs were removed in the left mid-axillary line. He had albuminuria, and had been aspirated three weeks and again two weeks before operation, pus having been obtained each time. He left hospital at his own request seventy-six days later.

Case 4.—A little girl, æt. 6 years, was admitted to hospital with a left empyema on the seventy-eighth day of her illness. Two inches of the fourth, fifth, and sixth ribs were removed in the mid-axillary line. She was one hundred and four days in hospital when the sinus with the contiguous rib-ends was excised, and a large sequestrum (Fig. 1) was removed on the two hundred and eightieth day after the first operation. There was a family history of tubercle, and the child had never been robust. She was known to have a sinus three and a quarter years after her first operation.

"How long is it after operation before the wound will be healed up?" is a question often put by patients or their friends. To answer this question is not easy, and it is impossible to say the exact day on which the wound healed. It must not be admitted to be healed till quite skinned over. It is inconceivable how difficult it is to get accuracy on this point, unless the patient has been under one's personal observation till the very end of the illness. I have been able to trace or watch thirty-three cases, and I find that the average duration after operation is forty-one days. There was a slight difference between the two sides; eighteen were right-sided empyemata and averaged thirty-seven days, while fifteen were left and averaged forty-six days after operation. Some of these healed cases merit remark on account of their persistence, but the first one I give on account of its short duration.

Case 5.—A child, æt. 2 years, had been ill for twenty-one days with a left empyema, for which portions of the fourth, fifth, and sixth ribs were excised and the pus and coagula turned out. The displaced heart at once returned to its proper place and the lung expanded fully. No drainage was required. The wound was dressed twice, and on the tenth day was found closed. Without the removal of the coagula, it is not possible that the parietal and visceral pleura could have come into contact so thoroughly, and the coagula could not have been removed without the excision of the ribs and the formation of an adequate opening.

Case 6.—A girl, æt. 5 years, with a right empyema, of which the
only history obtainable was that four days before admission to hospital 56 oz. of pus had been withdrawn by aspiration, had parts of the sixth, seventh, and eighth ribs removed in the axillary line. The sinus and surrounding ribs were removed one hundred and eighteen days later, and the wound was entirely healed on the one hundred and fifty-ninth day. The complication which delayed the healing was evidently the duration of the empyema before operation.

**Case 7.**—A man, æt. 30, of delicate appearance, though without definite tuberculous family history, had been ill for fifty-six days previous to admission, with a left empyema which formed a pulsating fluctuant tumour in the anterior axillary line between the sixth and seventh ribs. Portions of the fifth, sixth, and seventh ribs were resected, and much pus removed, along with coagula of such size that difficulty was experienced in removing them through the large opening. The lung showed no sign of expanding. On the eighty-seventh day after the first operation, I removed the second to the ninth ribs inclusive from their angles to their cartilages. The pleura was found to be 1½ inch thick, and was removed over the same area as the ribs. He was healed on the one hundred and twenty-eighth day (Plate VIII. Fig. 1). As in the previous case, the complication was probably the long duration of the empyema before operation.

**Case 8.**—A boy, æt. 4 years, had suffered from a right empyema for fourteen days. Parts of the fourth and fifth ribs were removed, and, convalescence proceeding normally, he went home on the seventy-sixth day, but returned later with a sequestrum lying loose among the granulations. This was removed with forceps, and the wound healed on the one hundred and forty-sixth day. The delay in closure was undoubtedly caused by the sequestrum.

**Case 9.**—A child, æt. 5 years, took ill with pneumonia forty-two days before admission to hospital. A right empyema was pointing in the posterior axillary line between the sixth and seventh ribs. It had been tapped fourteen days before admission, and fluid removed. The physical condition justified incision only. Thirty-two days later parts of the sixth and seventh ribs were removed, and on the one hundred and twenty-ninth day the fourth to the eighth ribs were freely removed. The wound was not closed till the four hundred and forty-sixth day, the delay being due to the physical deterioration produced by the long existing empyema.

**Case 10.**—A man, æt. 28, of tuberculous tendencies, had been ill for forty-five days with a right pneumonia followed by empyema, which had formed a pyo-pneumothorax. Four inches of the fifth, sixth, and seventh ribs were removed in the mid-axillary line. The empyema was an apex one, and on the one hundred and sixty-third day, the sinus, with the ends of the surrounding, and the third, fourth, and eighth additional ribs, were removed, and the wound was healed on the one hundred and ninety-second day.

**Case 11.**—A lad, æt. 14 years, had been ill for twenty-eight days with a left empyema following pneumonia. Parts of the fifth, sixth, seventh, and eighth ribs were removed in the mid-axillary line. The lung did not expand as I expected, and on the forty-eighth day the sinus and surrounding rib-ends were removed, and the wound was healed.
THE SURGICAL TREATMENT OF EMPYEMA.

on the one hundred and fiftieth day. There appeared to be an unusual want of resiliency in the chest wall in this patient.

Case 12.—General debility delayed the healing in the case of a boy, æt. 3 years, who, forty days before admission, had developed scarlet fever followed by nephritis, but it was not clear when the empyema had supervened. Parts of the fourth, fifth, sixth, and seventh ribs were removed in the right mid-axillary line. On the eightieth day, the sinus, with the cut rib-ends about it and part of the third rib, were removed. The cavity extended towards the apex, and the wound healed on the one hundred and forty-fifth day. Before the second operation he had a peculiar spasmodic cough, very suggestive of whooping cough, which at once and permanently disappeared after the operation.

That a pulmonary fistula is followed by delay in healing is shown by the two following cases:

Case 13.—A married woman, æt. 36, took ill with a right apical pneumonia. It was a sharp illness, and after improving a little she relapsed, and on the eleventh day began spitting up blood and fetid pus. On the fourteenth day of the illness I removed two inches of the fourth, fifth, and sixth ribs in the posterior axillary line, and found a very fetid empyema occupying the apex of the pleural cavity. Six months later the wound healed, and this was followed by a rise of temperature and some slightly fetid hæmoptysis. The cicatrix bulged and burst, and, being kept open by plugging as long as possible, ultimately healed soundly on the two hundred and fortieith day.

Case 14.—A man, æt. 25, of rather intemperate habits, was transferred to my care from one of the medical wards, suffering from right empyema following pneumonia. He had been ill for forty-nine days. Parts of the sixth, seventh, and eighth ribs were removed in the mid-axillary line, and a quantity of thick reddish pus removed. The lowest lobe of the lung felt solid, and occupied the back part of the chest. The discharge continued for a month or so, peculiarly reddened with blood, and then became brownish. He went home at his own request, almost healed. Two days later he was readmitted, with toxaemic swelling of the wrists and ankles. These untoward symptoms vanished as blood-tinged expectoration and discharge reappeared. In six weeks the discharge lost its red colour, and two weeks later he was again practically healed. He then suddenly developed slight hæmoptysis with pains all over, and swelling of the wrists, fingers, and knees, and a temperature of 102°. A probe, passed carefully through the healed wound in the direction of the empyema, entered, at three inches, a small sanguineous abscess. His hæmoptysis and cough at once ceased, and he continued to do well till the wound was finally healed on the one hundred and sixty-fifth day.

Case 15.—A boy, æt. 10 years, of poor physique and tuberculous tendencies, had been ill for sixty days. Parts of the third to the seventh ribs were removed in the mid-axillary line, and the lung found collapsed and the pleura thick and covered with fibrin and coagula. In the course of his convalescence he developed scarlet fever, and the wound was not closed till the two hundred and sixtieth day.

These cases show that delay in healing is not brought about
without some definite cause, and they illustrate some of these causes.

Four per cent. of my cases were chronic when they came under my observation. In brief detail these cases afford points of interest. The first was a man, æt. 41, who gave a history extending over four years. The empyema succeeded a left pleurisy with effusion following influenza. Four days after the onset he was tapped, and “two and a half bottles of fluid” removed. He was then aspirated once a week for four weeks, and then on two occasions a hypodermic needle was inserted, and on the last occasion “the doctor said the fluid had now become matter, and something else would have to be done.” Two days later an incision was made “at the base of the left lung,” and 34 oz. of pus were removed, and two drainage tubes inserted. After two months the tubes were left out, and this was followed by a rise of temperature, necessitating enlargement of the sinus and reintroduction of the tubes. Three weeks later he first came under my care. I removed pieces of four ribs, and in seven months he went home with a sinus. Nineteen months thereafter, in a much improved physical condition, he was readmitted to my care in hospital, and I removed the second to the ninth ribs with the thickened pleura. He went home after forty-seven days in hospital, and I hear that he is now well and working. I do not fear contradiction when I say that this case became chronic on account of the delay and inefficiency of the earlier treatment.

The second was that of a man, æt. 36, who, when I saw him first, had a left empyema of three years’ duration. Though there was no history of tubercle in the family, his illness began with an ordinary attack of pulmonary phthisis, for which he was treated, and a year later he had a severe attack of pleurisy. A month or two after his recovery from this, he noticed splashing in his chest when he walked. In June 1897 he was aspirated, 106 oz. of turbid purulent fluid being withdrawn, and next day 100 oz. similarly removed. He was aspirated twice with benefit in September of the same year. Just before being sent to me, in December 1898, he had been tapped of 44 oz. of thick pus. Six days later I removed four inches of the third, fourth, and fifth ribs in the mid-axillary line, and evacuated a large quantity of pus. Fourteen months afterwards I removed the second to the tenth ribs inclusive, along with the thickened pleura over this large area. The pieces of ribs removed varied from two to nine inches. Soon after that he returned to his work, though the sinus was not healed. I reopened the sinus nine months later, and, finding a considerable cavity at the apex, removed two to three inches of the anterior parts of those ribs which had been cut before. The cavity then closed entirely, and in six weeks he returned to his work. Until recently, when I saw him again, he had been constantly at work, and weighed fourteen stone, and he had ex-
The condition of his chest is shown in Plate VIII. Figs. 2 and 3. Though the delay in the treatment of this case was probably the cause of the empyema becoming chronic, it also played no small part in the healing of the phthisis in the lung. I do not think the surgical interference would have been attended with the same happy result had it been carried out while the phthisis was active.

The third case was also a man, aged 36, with a left empyema. In July 1896 the chest was aspirated, and later incised and drained. Three weeks later two ribs were partially removed, to facilitate drainage, and he was in bed for seven months. A counter opening was made in January 1898, and the wound healed in April. He was sent to me in March 1899, because a few weeks previously the wound had broken down, and was again discharging pus. I removed the sinus with the surrounding ribs (Plate VIII. Fig. 4), and the fourth to the tenth ribs inclusive, from their cartilages to their angles. Even with this extensive resection, the sinus which remained had to be reopened and enlarged five months later before the cavity completely closed. He has remained well and at work since.

The last case of chronic empyema which I include in my series was a man, aged 25, whose empyema apparently began with a right pleurisy fourteen months before I saw him. The existence of fluid was overlooked, and apparently the case treated as one of phthisis. For three months at least before I operated on him, he had been coughing up huge quantities (up to 37 oz. daily) of fetid expectoration. I resected about four inches of the fourth to the eighth ribs inclusive, and found a thick-walled cavity, extending from the apex to the sixth rib, containing very thick greenish-yellow pus. The lung was much retracted, and there were bands of fibrous tissue stretching across the cavity. The communication between this cavity and a bronchus was quite apparent. He was much relieved by the operation, but six weeks later developed symptoms of cerebral abscess, and died.

Notwithstanding the untoward result of the last, these cases illustrate well the great benefit to be expected from surgical interference in cases of long-standing empyema, provided the operation be extensive enough and there is no active phthisis.

In conclusion, I wish to repeat that the most satisfactory results in the surgical treatment of empyema are obtained in chronic or acute cases by a free opening into the chest, with excision of ribs in the axillary line at the earliest possible moment. The only exception to this is when there is active phthisis present. Fifty-two per cent. of my cases occurred in children, and though my figures are few, I find that under 30 years of age the proportion of deaths is 1 in every 4.13, while above 30 years of age it is 1 in every 3.15, and this includes all cases, even phthisical ones, where the recovery from the empyema depends on the
curability of the phthisis. To quote the mortality table with which I opened this essay:

The mortality after aspiration is 87.5 per cent.
" aspiration followed by incision is 62.5 "
" incision alone is 33.3 "
" excision of ribs is 25.0 "

Taking together all the cases I have gathered in a previous decade, not before the days of antiseptic treatment of wounds, the mortality reaches 48.27 per cent., with which my 25 per cent. mortality, after excision of ribs, compares favourably.

I need not recapitulate the other points which I have dealt with throughout the paper, but I will refer to three points only. First, in cases where ribs are removed, a second operation is required in 10 per cent., but in cases where this is not adopted, a second operation is required in 66 per cent. Second, that in hospital cases treated by other treatment than by excision of ribs, the average stay of each patient in the institution is one hundred and eight days; it is lessened to sixty-eight days in cases treated by excision of ribs. Third, that in a straightforward case, without any complication, in a young adult or child, the average duration of the wound after operation is fifty-three days.

GALL STONES.

By RUTHERFORD MORISON, F.R.C.S., Surgeon to the Royal Infirmary, and Consulting Surgeon to the Dental Hospital, Newcastle-on-Tyne.

Statistics.1

Cholecystotomies, seven cases; all recovered.
Cholecystostomies, eight cases; all recovered.
Cholecystectomy, one case; recovered.
Choledochotomies, five cases; one recovered, four died.
Gall stones not operated on; two cases.

Of the twenty-one cases operated on, seventeen recovered and four died.

Ten years ago, in introducing a discussion on gall stones,2 I made some suggestions, based on general principles of surgical pathology, as to the causes of the symptoms and the physical conditions met with in cases of cholecystolithiasis. Time has only served to convince me of their truth and usefulness; and as they have not yet received the recognition which I think they deserve, I intend in the present paper to restate them, together with my conclusions

1 Statistics supplied by G. Grey Turner, Surgical Registrar, Royal Infirmary, Newcastle-on-Tyne, of cases of gall stones operated on by Mr. Morison during 1903 in the Royal Infirmary and in a private hospital at Newcastle-on-Tyne. Drawings by W. G. Richardson, F.R.C.S.
2 Jour. Northumberland and Durham Med. Soc., 1895, p. 21.