that precisely similar effects were obtainable by the use of *B. coli* vaccine, and that therefore there was nothing specific about the treatment. Miller and Lusk² reported striking results in arthritis, and Engman and McGarry³ in certain skin diseases by means of the vaccine, the reaction being in every respect identical with that which I had obtained with the colloidal platinum. "Non-specific vaccine therapy" and "protein shock therapy" were applied to the procedure. I can certainly add my testimony to the remarkable effects of the treatment in cases of recent arthritis.

When the supply of active colloidal platinum I had been using was nearly exhausted I was unable to obtain any colloidal metallic preparation capable of producing the reaction. It was not until September, 1917, I obtained a specimen of colloidal silver, which, in doses of 3 to 5 c.cm., acted with particular intensity, even more so than the platinum colloid. Being informed by the manufacturers that this silver was protected in a special manner, I requested them to send me the protective suspension exactly as used, which they willingly did. On trying it clinically, I was somewhat surprised to find that it reproduced very faithfully the effects of the colloidal silver itself, bulk for bulk. The protective used was given as veal peptone 0.4 per cent., with 1 per cent. glucose. It gave a violet biuret reaction. The veal "peptone," of course, was the active agent, as the effect of the glucose alone was nil. The result was surprising also in view of the fact that I had frequently given larger doses of peptone intravenously without reaction. Such a discovery naturally led me to suspect all the colloidal metals supplied, as they all contain some albuminous substance as protective. Most of those I had used, including the very active platinum, were protected by gelatin. The gelatin protective was also prepared for me and on injection it certainly produced symptoms such as headache and malaise, but without the rise of temperature found in the active platinum. Whether this latter preparation owed its properties to an unusual state of dispersion of the platinum particles, or to some accidental impurity such as hydrazin, or to some toxic body formed by hydrolysis of the gelatin after prolonged keeping, is difficult at present to decide. Examined under the ultra-microscope, the platinum was certainly in a very fine state of division, and showed active Brownian movements. Although doubt is thus thrown on the colloidal metals, it cannot be affirmed that they are clinically inactive, as they may certainly produce results which are not accompanied by high temperature reactions. It is, however, very desirable that they be issued in a purer and more standardized form.

If the pyrogen which produced the reactions was not colloidal platinum it matters little therapeutically, as all pyrogenic substances in appropriate doses produce the same effects, whether killed bacteria, proteoses, nucleic acid, or protected colloidal metals, to mention only a few.

How is the reaction brought about? This is a disputed point. The minute quantity of certain of the pyrogenic substances necessary, and the apparent possibility of producing in experimental animals similar symptoms by such inert (non-protein) substances as kaolin and agar, would seem to favour the view which has recently been elaborated from a large number of experiments by Novy and De Kruif,⁴ that the matrix of the pyrogen is in the plasma; that it is always one and the same substance, namely, anaphylatoxin, and the antigen merely serves to evolve it. This is the reverse of the split protein theory of Friedberger and Vaughan.

The favourable effects (which in a considerable percentage of the cases means the termination of the disease by crisis) have been variously ascribed to leucocytosis, to rapid mobilization of antibodies, to stimulation of the non-specific ferments of the serum (protease and lipase), and alteration in the ferment-antiferment titre. Teague and McWilliams⁵ in an experimental investigation have not been able to confirm these as causal agents. They suggest an active passage of bacteriolytic substances from the blood into the lymph spaces which traverse the local area or areas of infection. Doubtless various factors are at work, but without the pyrexia there is no benefit.

Under present conditions, typhoid vaccine is probably the best pyrogen to use. Nucleic acid (2 per cent.) is not always available in a reliable form, and the same applies to albumose. From fifty to two hundred and fifty million

of killed typhoid bacilli are injected intravenously, according to the strength of the patient and the existing state of the temperature. In apyrexial cases, as in many of the arthritics, the dosage should be greater than in cases of pyrexia. The treatment is specially adapted to sluggish cases of localized infective diseases, with low or moderate pyrexia. Little benefit results unless the full reaction is induced, and rarely more than one injection is necessary. An overdose is indicated by dyspnoea, cyanosis and diarrhoea. The injection should not be given while the temperature is high. Heart disease, high blood pressure, and rigid arteries are contraindications. With care in the selection of cases, the treatment is not dangerous and it is not necessary to produce "shock," nor is the expression "shock" therapy in my view desirable. As an antidote to this, I have used the prefix "pyrogenic."

It is a pleasant duty to acknowledge my indebtedness to Professors Bayliss and Donnan of University College, who have kindly granted me opportunities of consulting them in respect of certain problems presented by colloids and electrolytes.

REFERENCES.

¹ *Journ. Amer. Med. Assoc.*, June 3rd and August 7th, 1916, pp. 1753 and 515. ² *Ibid.*, June, 1916, p. 1756. ³ *Ibid.*, December 9th, 1916, p. 1741. ⁴ *Journ. Infec. Diseases*, May and June, 1917. ⁵ *Journ. of Immunology*, February, 1917, p. 167.

TREATMENT OF WOUNDS OF THE CHEST,

WITH SPECIAL REFERENCE TO INFECTED
HAEMOTHORAX.

BY

MAJOR WILLIAM HUTCHINSON, C.A.M.C.

At the beginning of the war we were interested merely in the question of diagnosis of a haemothorax and whether or not aspiration of the blood was worth while. Fortunately it did not take very long to settle this latter point, and aspiration very quickly became a routine procedure. Simple aspiration was very soon followed by replacing the aspirated blood with oxygen in order to do away with the disagreeable symptoms sometimes produced by the rapid removal of a large quantity of blood from the pleural cavity. Thus, as far as the treatment of a simple haemothorax was concerned, perfection was reached; but there were other and more serious problems to be solved, and it was in the solving of those the most striking advance was made during the past year.

The problems with which we were confronted were three in number: how to deal with an open pneumothorax; how to deal with an infected haemothorax; how to deal with a foreign body in the lung. During the three years of the war a great deal of work has been done on these problems, and I am glad to say they have been solved.

In the treatment of wounds of the chest four classes must be distinguished.

I. A Non-infected Haemothorax or Pneumo-haemothorax.

The treatment of a simple non-infected haemothorax or a pneumo-haemothorax consists in merely aspirating the blood from the pleural cavity. This should be carried out in all cases in which more than two fingerbreadths of dullness can be made out. In my series of 450 cases 368 were aspirated; in the remainder there was not sufficient fluid to warrant it. The aspiration is done by means of the ordinary aspirating apparatus, but there are one or two practical points which, if carried out, make the procedure easier both for the patient and the surgeon. A local anaesthetic should be injected into the skin, muscles, and pleura in order to make the aspiration as painless as possible. After the injection of the anaesthetic a tiny incision should be made through the skin so that the round cannula will not be gripped by it. In the next place it is important to use a fair-sized trocar, as small needles are very easily blocked; another advantage in using a trocar is that when the sharp obturator is removed the blunt cannula can be moved about the pleural cavity without damaging the lung. If during the aspiration the patient begins to suffer pain in the chest and shortness of breath, the trocar can be disconnected

from the bottle and a little air allowed to enter the pleural cavity, and it will then be found that more blood can be withdrawn before the pain and distress return. In commencing to aspirate a chest, especially in cases in which a quantity of air is present in the pleural cavity, the bottle should not be exhausted before the trocar is connected, but should be exhausted gradually during the whole aspiration, as the sudden evacuation of air when the tap is opened might cause alarming symptoms.

The treatment of non-infected haemothorax in which there is a large amount of blood clot requires special mention, as there is a difference of opinion as to the course to be pursued. Personally, I believe the chest should be opened, all the blood and clot removed, the pleural cavity closed and the air aspirated. I would also recommend that this be done as early as the patient's condition will permit, as then the lung will get a chance to expand before adhesions form. There are two reasons for this: first, the removal of blood and clot by aspiration is impossible, and therefore we must depend upon absorption to remove them, and as this is necessarily a slow process the lung remains compressed for a long time and adhesions between the compressed lung and the chest wall become very firm; secondly, these cases in my experience formed the great bulk of the infected ones, and I am sure had they been treated by operation in the first place they would have escaped infection.

II. Open Pneumothorax.

The treatment of an open pneumothorax has been greatly improved during the past year and the results obtained at the casualty clearing hospitals are very encouraging. In this condition it is important to clean the wound thoroughly, to wash out the pleural cavity with saline, and to close the chest completely. This should be done early, as the condition of shock will be relieved by the closure and the danger of infection also decreased. If the patient's condition will stand it and the foreign body is fairly accessible it should be removed. If there seems a likelihood of infection having taken place, then 3 oz. of 1 in 5,000 flavine solution should be left in the pleural cavity and the usual after-treatment of an infected haemothorax carried out.

III. Infected Haemothorax.

We now come to the treatment of the most serious complication of chest wounds with which we have to deal at the base in France—that is, a haemothorax which has become infected. While doing surgical work in France during 1915-16 I was impressed by the great improvement in the results obtained by the cleaning out and closing of knee-joints which had become infected over the results obtained by the old method of drainage. In reviewing the good results obtained by closing the peritoneum in cases of general peritonitis, I came to the conclusion that if the lining membrane of the knee-joint and the peritoneal lining of the abdominal cavity could look after a considerable amount of infection, the pleura ought to be able to do the same. I therefore decided to apply this principle to the treatment of an infected haemothorax, and in the beginning of 1917 I initiated the line of treatment which I shall describe below. Before describing operative technique, I wish to say one word against palliative measures in these cases. Simple aspiration in infected cases is of no avail, as in the first place it is impossible to remove all the blood from the chest by this means, and in the second place the clot, in which lies the focus of infection, cannot possibly be removed through a trocar. Again, it is impossible to sterilize the clot by any known antiseptic which can be used in the pleural cavity, and therefore the only possible means of treating these infected cases is by operation.

The method to be applied in these cases is as follows: As soon as a haemothorax is found to be infected—by that I mean clinically and bacteriologically (not merely bacteriologically)—the patient is taken to the operating room and nitrous oxide and oxygen administered. A portion of rib, long enough to allow the hand to be passed through the opening, should be removed and the blood allowed to flow out. The clot is then removed by the hand, all parts of the cavity explored, and light adhesions broken down. Then by means of large pieces of gauze on dressing forceps the remainder of blood and clot is removed. After this the cavity should be washed out with saline and again mopped out and a running suture inserted in such a way

as to include the pleura and intercostal muscles. This suture should be left quite loose, so that a small quantity of some antiseptic can be poured into the pleural cavity. This antiseptic should be spread all over the walls of the cavity by means of a small piece of gauze on long dressing forceps. As soon as this has been done the running suture is drawn tight, thus closing the pleural cavity completely. The muscles and skin are then closed and a dry dressing applied.

Forty-eight hours after the operation the chest should be aspirated, thus removing a quantity of serum and air. This is done for two reasons—first, the serum by that time has lost its bactericidal properties, and then only becomes a menace; and secondly, by removing a good deal of the air from the pleural cavity a negative pressure is obtained which helps to re-expand the lung. It will be found that three or four aspirations are necessary during the course of convalescence.

The antiseptics which I have used in these cases include eusol solution, 1 in 2; a suspension of bipp in liquid paraffin in the following proportions, bipp $\frac{1}{4}$ oz., liquid paraffin 6 oz.; flavine solution 1 in 5,000, and normal saline, the amount left in the chest being 3 oz. The results from 29 cases treated in this manner are as follows:

		Remained Closed.	Reopened.
Eusol ...	...	2	5
Bipp ...	...	11	4
Flavine ...	...	2	3
Saline ...	...	1	1
Total ...	...	16	13

When considering this method of treatment the question naturally arises as to what cases should be treated in this way. In answer to this, I may say that at present I am inclined to close every case, and if the patient shows signs of becoming worse after the first post-operative aspiration, then it will be time enough to drain.

There are, however, certain types of infection which lend themselves to this form of treatment better than others, as the following table will show:

	Remained Closed.	Reopened.
<i>B. aerogenes capsulatus</i> ...	11	3
<i>Streptococcus</i> ...	1	6
<i>Staphylococcus</i> ...	1	0
<i>Pneumococcus</i> ...	1	2
<i>Diplobacillus</i> ...	1	0
Mixed infection ...	1	2

There is one point in the technique of the treatment by drainage which I wish to point out, and that is that the constant washing of the pleural cavity in early cases is harmful. In place of this washing the occasional filling of the cavity with a eusol solution 1 in 3 and good drainage should be substituted. In this way the body is stimulated to pour out serum into the cavity, which washes the pyogenic membrane from within outwards instead of merely washing its outer surface. In order to do this the patient is placed on his good side, so that the opening of the chest wall will be the highest point; a 1 in 3 solution of eusol is then allowed to flow gently into the cavity until it is filled, and then the patient is turned over and the fluid allowed to run out. This is repeated every second or third day, depending on the condition of the patient.

IV. Foreign Body in the Lung or Pleural Cavity.

A great deal of controversy has taken place during the past three years as to the treatment of a foreign body retained in the lung. I have had the opportunity of treating a large number of cases and have talked to a number of surgeons and physicians, and as the result of my own experience and that of others I have come to the conclusion that the question must be decided separately in three types of hospitals: the casualty clearing hospital, the base hospital in France, and the base hospital in England; and that a surgeon in one area is not in a position to dictate to a surgeon in any other area. As all my work has been done in a base hospital in France, I am only in a position to discuss the treatment which should be carried out in cases with retained foreign bodies in the lung during the interval from the time they leave the casualty clearing hospital to the time they arrive in England.

As a result of experience with 450 cases, and from reports received from other surgeons similarly situated, I

am convinced that no attempt should be made to remove the foreign body from the lung while the patient is in a base hospital in France.

RESULTS.

In my series of 450 cases there were 27 deaths, the causes of which when examined will show the hopelessness of certain cases and will also point to one problem in surgery which has not been solved—that is, cases in which the infected haemothorax is pocketed. In these 27 cases the causes of death were as follows:

1. Septicaemia, due to pocketing	Drained.
2. Septicaemia	Drained.
3. Septicaemia	Drained.
4. Abscess of lung	Drained.
5. Pneumonia and empyema (opposite side), haemothorax	Drained.
6. Gangrene of lung	Drained.
7. Septicaemia	Drained.
8. Septicaemia	Drained.
9. Moribund, time of operation	Drained.
10. Septicaemia, due to pocketing	Closed and reopened.
11. Septicaemia, due to pocketing	Closed and reopened.
12. Septicaemia, due to pocketing	Closed and reopened.
13. Pyaemic abscesses (both lungs)	Closed and reopened.
14. Pneumonia and empyema (opposite side), haemothorax	Closed and reopened.
15. Acute gas gangrene of chest wall	Closed and reopened.
16. Septicaemia	Closed and reopened.
17. Septicaemia	Closed and reopened.
18. Gas gangrene of chest wall	Closed and reopened.
19. Double pneumonia	No operation.
20. Bronchopneumonia and tuberculosis	No operation.
21. Septicaemia	No operation.
22. Gas gangrene (one side), pneumonia and empyema (opposite side)	No operation.
23. Streptococcus (arm), mediastinitis, abscess of lung	No operation.
24. Pneumonia (opposite side)	No operation.
25. Double bronchopneumonia	No operation.
26. Secondary pulmonary haemorrhage, infected haemothorax	Drained.
27. Died on table, before operation.	

CONCLUSIONS.

1. All cases of wounds of the chest should be treated in special wards or special hospitals.
2. Careful charts should be kept which record temperature, pulse, and respirations four times a day.
3. Early diagnosis of infection is important.
4. Every case in which there is more than two finger-breadths of dullness should be aspirated.
5. Cases of open pneumothorax should be closed as early as possible.
6. Cases in which there is a large amount of clot in the chest should be opened, blood and clot evacuated, and the chest closed. This should be done as early as possible.
7. Cases in which the haemothorax is found to be infected should be opened, washed out, and closed, some antiseptic being left in, preferably an emulsion of bipp in liquid paraffin.
8. Post-operative aspirations must be done in all closed cases the first forty-eight hours after operation.
9. No attempt should be made at the base in France to remove a foreign body from the lung.

THE MODERN TREATMENT OF EMPYEMA BY ANTISEPTICS.

By R. ATKINSON STONEY, F.R.C.S.I.

VISITING SURGEON, ROYAL CITY OF DUBLIN HOSPITAL; MÉDECIN MAJOR 2ÈME CLASSE, ARMÉE FRANÇAISE.

For all practical purposes cases of empyema may be divided into two classes—(a) those easily cured by simple surgical methods, and (b) those difficult or impossible to cure even by such extensive surgical operations as Estlander's or Schede's thoracoplasty or pulmonary decortication.

This difference is chiefly due to the fact that in the latter cases the condition has become chronic, either through neglect or inefficient surgical treatment in the early stages, with the result that the lung and diaphragm have become covered by granulation tissue, which by its further development into fibrous tissue renders the walls of the pus-producing cavity rigid so that they cannot collapse and so obliterate the cavity. Down to quite recently it has generally been believed that an empyema could be cured only when the cavity of the pleura was obliterated either by distension of the lung to meet the chest wall, or collapse of the chest wall to meet the

lung; the first process occurring in those cases that were easily cured, and the latter being brought about by Estlander's or Schede's operation in the cases which resisted ordinary treatment.

That this idea was wrong is, I think, proved by the histories of the following three cases treated in France last year:

CASE I.

Arab, aged 17, found during the inspection of an outlying hospital, with an empyema of the right side which had burst through the chest wall in two places—in the fourth space in the nipple line and in the sixth space in the anterior axillary line. He had an evening temperature of 102° to 104°, and was in a very weak and emaciated condition. On May 19th a piece of the eighth rib was removed in the scapular line, and the pleura opened. One pint and a half of odourless pus was evacuated, and the pleural cavity was freely douched with Dakin's solution and hot water, and a large double drainage tube inserted. He was dressed daily and syringed with Dakin's solution and hot water. The discharge, which was at first very copious, rapidly diminished, and at the end of four weeks there was only a little serous discharge on the dressings, though there was still a large intrapleural cavity, shown by the fact that from 6 to 8 oz. of lotion could be injected without pressure or discomfort. The drainage tube was left out and the wound closed without rise of temperature; on two or three occasions during the following week a probe was inserted, but, as only a little clean serum escaped and there was no further rise of temperature, the wound was allowed to cicatrize, and the patient was discharged in the beginning of July. The physical signs showed that the lung was still contracted and that there was a considerable pneumothorax.

CASE II.

An Arab, aged 18. This case was very similar; he had an empyema of the left side which had burst through the chest wall and formed a large subcutaneous abscess over the sixth space in the nipple line. On June 1st a piece of the eighth rib was removed in the scapular line, and when the pleura was opened nearly four litres of thin, foul-smelling pus escaped. The pleural cavity was douched with Dakin's solution and hot water and a large double drainage tube inserted. The further history and treatment was the same as the previous case. In three weeks the discharge had lessened so much that the drainage tube was left out and the wound closed. Here again a probe was passed on a couple of occasions and only a little serum escaped. He was discharged healed, early in July.

CASE III.

A French soldier, aged 30, said that he had been partially buried by an explosion nine months previously. An operation was performed and a tube put into his left side, from which there was daily discharge up to the time he was seen by me, last June, when he had a sinus in the posterior axillary line, about the level of the eighth rib, through which a probe could be passed for six to eight inches. The discharge was copious, and there was a slight evening rise of temperature. The sinus was enlarged, a drainage tube inserted, and the cavity washed out daily with Dakin's solution and hot water. The discharge lessened rapidly and the temperature became normal; the tube was left out at the end of three weeks, and the discharge being only serous the wound was allowed to close and the patient was discharged from hospital at the end of five weeks, healed and apparently well, though he still had a considerable pneumothorax.

The first two cases were neglected acute empyemas which had been allowed to burst externally, in fact the "empyema of necessity" of the early writers; and the third case was probably a haemothorax, which had been drained and allowed to become septic. In all three cases the result of treatment came as a great surprise, as it had been thought that an extensive operation would have been necessary; the drainage and douching was only done as a preliminary measure to get the cases as clean as possible before undertaking an Estlander's operation.

Since treating the above cases and returning to Dublin, I have read of Tuffier's treatment of empyema by the Carrel-Dakin method. He claims the same results—that is, that the discharge gradually lessens and finally is only serous, and as soon as this occurs, or it is proved that the discharge is sterile or almost so, by bacteriological examination, he removes the tubes and allows the wound to close. He draws attention to the fact that the patient is cured and the thoracotomy wound closed, while there is still a free space in the pleural cavity, and this is the real crux of the whole subject; for up to this all our efforts have been directed to obliterating this space, as it was considered impossible to obtain a cure of a case of empyema until this space had ceased to exist. In future our efforts must be directed to sterilizing the walls of this space, which has been proved to be possible, perhaps not in every one of these cases, but certainly in a large number of them. Whether we attempt to do this, as outlined in the above cases, by frequent washing with some reliable antiseptic by