it was common following the celebrations of Independence Day on July 4th. In America,¹ in 1903, despite official warnings, over 400 patients died from tetanus due to this cause alone. The incubation period was short and the disease very virulent. In the majority of cases the wounds were in the hands. Recommendations were made regarding the sale of toy pistols and blank cartridges and the giving of antitetanic serum in all wounds of this nature. This reduced the mortality to three in the 1914 Independence Day celebrations.

Miss Smith² reported four cases with three deaths, occurring in London in 1932. The wadding of the blank cartridges was examined for *B. tetani*, but none were found. However, other anaerobes were isolated, particularly *B. sporogenes*. She points out that this does not exclude *B. tetani*, as it is difficult to isolate *B. tetani* from mixed company. In America, following the 1903 cases, a large number of blank cartridges were examined, but in no case was *B. tetani* found, although one culture, inoculated into rats, caused death from convulsions. Other instances of death from tetanus associated with toy-pistol wounds were reported by Stokes,³ Schofield,⁴ and Clark Trotter.^{5, 6} In Dr. Clark Trotter's case the cartridges were examined by Professor McIntosh, and *B. tetani* was found. It was observed then that only in those cartridges with a wad containing hair felt was the organism obtained. Dr. Clark Trotter remarks that thorough sterilization, before being used as a wad, is the only certain way of preventing these accidents.

There is, of course, no direct evidence that the tetanus infection in this case was derived from the cartridge, but the frequency of tetanus after wounds due to the use of toy pistols and blank cartridges suggests that either the infecting organisms were already present in the cartridge or that the type of wound, associated with mild sepsis, may predispose to tetanus infection. The rarity of tetanus seen at the out-patient department of a large hospital, such as the Glasgow Royal Infirmary, which deals with a very large number of street accidents, would suggest that either of these two reasons is correct. It is important that the general public and the medical profession should be aware of this possible danger from toy-pistol wounds, so that early treatment can be given, as, once the disease is established, the prognosis is well-nigh hopeless.

I am indebted to Mr. Dunbar of the Glasgow Royal Infirmary for allowing me to publish this case, and to Professor McIntosh and Dr. Cruickshank for the bacteriological examinations, and also to Dr. Clark Trotter for sending me a copy of his annual report.

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THE TREATMENT OF PNEUMOCOCCAL EMPYEMA WITH BILE SALTS

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The lysis of pneumococci by bile was noted by Neufeld¹ over thirty years ago, and Levy² in 1907 proposed its use as a differential test between pneumococci and streptococci of the *viridans* group. Many workers have sought for a chemotherapeutic agent in the treatment of pneumococcal infections—notably Lamar,³ Morgenroth and Levy,⁴ and Felton.⁵ Cocchi⁶ in Italy and Thomson⁷ in this country have described the treatment of pneumococcal empyema by aspiration of the pus followed by the injection of a solution of sodium taurocholate. This method appeared to offer so many advantages that we decided to try it, and in our first cases we used the 20 per cent. solution of sodium taurocholate recommended by Cocchi.

It has been customary for some years in this laboratory to add 0.1 c.cm. of a 10 per cent. solution of sodium desoxycholate to 5 c.cm. of broth culture (brought to pH 7.8) as a test for pneumococci. Lysis should occur within five minutes. This modification of the classical test was made following the suggestion of Mair,⁸ and laboratory experience of the varying potency of individual samples of commercial sodium taurocholate. In addition, there is the advantage of using a substance which is chemically pure. We accordingly decided to try this salt clinically.

Before doing this we made *in vitro* experiments to compare the lytic potency of the sodium taurocholate in use with that of sodium desoxycholate. A thirty-hour broth culture of the strain of Type I pneumococci, recovered from one of the cases undergoing treatment,

was used. Before adding the substances under test the broth reaction was adjusted to pH 7.8. It was found that whereas 0.2 gram of sodium taurocholate (1 c.cm. of a 20 per cent. solution) was required to produce lysis in 5 c.cm. of the broth culture, 0.0125 gram (0.25 c.cm. of a 5 per cent. solution) of sodium desoxycholate achieved the same result—that is, the sodium desoxycholate is sixteen times more potent.

We endeavoured to assess the toxicity of the desoxycholate by animal experiment. Three 250-gram guinea-pigs were taken. The first received 1 c.cm. of a 10 per cent. solution intraperitoneally, and death occurred in twelve hours. The post-mortem revealed intestinal necrosis with haemolysis. The second received 1 c.cm. of a 2.5 per cent. solution intraperitoneally with no observable ill effect, while the third received 1 c.cm. of a 10 per cent. solution intramuscularly into the thigh and survived. We realized also that absorption might produce severe haemolysis, for *in vitro* experiments showed that it is over a hundred times more haemolytic for washed sheep's red corpuscles (fragility 0.65–0.5) than sodium taurocholate. For these reasons we have not injected sodium desoxycholate into an empyema until the presence of frank pus shows that a definite abscess cavity has formed.

Method of Use and Results

The technique of the treatment of empyemata by the injection method is simple. The presence of pneumococci in the pus must first be confirmed, since it is only on these organisms that lysis takes place. The abscess cavity is then aspirated again, and as much pus as possible drawn off. With the needle still in position the solution of sodium desoxycholate is injected, and we have used from 5 to 20 c.cm. of a 5 per cent. solution of the salt.

The best results seem to be obtained by repeating the aspiration and injection daily, or every other day, in the early stages, but the length of time that can be

allowed to elapse can be gauged by the general condition of the patient, the amount of pus withdrawn, and the results of microscopical examination and culture of the pus. We have found radiograms of the chest of considerable assistance in estimating the quantity of fluid present. It is essential that strict surgical asepsis must be maintained, as it is very easy to introduce secondary organisms where frequent aspiration is being undertaken, and if this occurs it will, of course, necessitate the institution of continuous drainage. The use of a trocar and cannula has been advocated for puncture of the chest wall⁷ in order to prevent the carriage of a punched-out portion of skin by an exploring needle, but we have not found this necessary. In a favourable case the temperature rapidly falls, the general condition of the patient improves, and the pus becomes thinner. In some cases the salt tends to jelly, particularly where relatively large quantities of the solution are injected into a small quantity of pus, but we have not found that this has interfered materially with aspiration.

Cocchi has suggested that the bile salts, besides causing lysis of the organisms, may have some action in producing liquefaction of the fibrin, which is usually formed in such large amounts in the pleural cavity. Certainly we have never found the needle to block during the aspiration, and at the end of treatment the clinical signs and clearness of the chest to *x* rays indicate a small degree of pleural thickening. The latter is, however, probably due partly to the avoidance of secondary infection and the absence of irritation caused by a drainage tube. Examination of the pus during the course of treatment showed characteristic changes. At the commencement microscopy revealed 95 per cent. polymorphonuclear pus, with the field crowded with diplococci. The first change noted was a marked reduction in the number of organisms and disintegration of the cellular constituents. Finally, the aspirated material consisted of amorphous debris with no intact organisms, but revealing occasional swollen cocci on prolonged search. Under these circumstances cultures were negative.

Although we have only had the opportunity of employing sodium desoxycholate in two cases it seems to offer both practical and theoretical advantages over sodium taurocholate, and in view of this we feel justified in bringing it forward in the hope that it may be subjected to a more extended clinical trial than we are able to give.

Case Records

Case 1.—M. E., aged 4½. Admitted January 9th, 1934, with signs of a left-sided empyema following pneumonia. Temperature 101–102° F., pulse 130–146. Chest aspirated, and 80 c.cm. of purulent fluid withdrawn. Culture showed pneumococci Type I. On January 12th 45 c.cm. of thick pus removed; 5 c.cm. of 20 per cent. sodium taurocholate injected. Aspiration and injection repeated daily, and by the 17th the temperature was normal, pulse 80–100, and the pus thin and sterile on culture. The frequency of aspiration was reduced. On February 2nd 200 c.cm. was withdrawn, and culture showed numerous pneumococci. Two days later, although the general condition remained satisfactory, the temperature began to rise, and ranged from 99° to 100° in the evenings, and the pulse varied between 100 and 120. It was about this time that we started a fresh batch of taurocholate, but the exact date is uncertain. This taurocholate was tested against cultures of the organism, and gave apparently satisfactory results. The boy continued to have an evening rise of temperature, and rather rapid pulse throughout the month of February, but his general condition remained surprisingly good. The pus withdrawn was rather thicker again, and pneumococci were usually grown on culture. On March 3rd we decided to try injections of sodium desoxycholate, and he was given 10 c.cm. of a 5 per cent. solution. The temperature was normal on the evening of the 5th (two days later), and did not again rise above

the line. The pulse rate fell, to reach normal a few days later. The amount of fluid on aspiration rapidly decreased, and was sterile on culture. Treatment was stopped on March 15th, but a week later a few cubic centimetres of serous fluid were withdrawn. He was discharged on March 17th, and a radiogram at this time showed a practically clear left base. He was seen after a month's interval, and had remained perfectly fit.

Case 2.—H. T., aged 15. Admitted March 18th, 1934, three weeks after the onset of pneumonia, with signs of right-sided empyema. Very cyanosed and toxic. Temperature ranging between 101° and 103° and pulse 120–130. On aspiration 23 oz. of pus were removed. Culture showed pure growth of pneumococci Type I. On March 19th 12 oz. of pus were removed and 10 c.cm. of sodium desoxycholate injected. The aspiration and injection was repeated every second day, and although the amount of pus withdrawn fell in about a week to 50–60 c.cm., he had all the signs of a solid right lung, and the temperature persisted between 99° and 100°. There had been complete absence of sputum during the course of the pneumonia, but he now began to bring up fairly large quantities of thick, muco-purulent sputum, which contained abundant pneumococci. We decided the condition was one of unresolved pneumonia, and that the pleural cavity was being continually reinfected from the underlying lung. In view of this, and as his general condition was much improved, we attempted to keep the empyema under control by repeating the aspiration and injection every few days, and the amount of pus drawn off varied from 10 to 60 c.cm. Although the direct smear showed a greatly reduced number of organisms the culture remained positive. He was given the usual medical treatment, and the signs in the right lung cleared very slowly. Coincident with this the sputum decreased and the temperature returned to normal. By April 26th the right lung seemed sufficiently normal to suggest that the empyema might remain sterile. The cavity was aspirated, and 15 c.cm. of 5 per cent. desoxycholate injected daily for four days. The temperature remained normal, and the cultures became sterile. On the last aspiration, on the 29th, only a few cubic centimetres of fluid were withdrawn.

In view of the fact that simple aspiration alone will sometimes cure a pneumococcal empyema in children it seems worth while to record the case of an adult treated by aspiration and injection of bile salts.

Case 3.—A. P., aged 21. Admitted January 15th, 1934, with signs of left-sided empyema following pneumonia. General condition very poor. Temperature 101°, pulse 120. On aspiration 200 c.cm. of straw-coloured fluid was removed. Abundant organisms seen on smears. Culture: pneumococci Type I. January 20th: On aspiration 350 c.cm. of pus was obtained, and 10 c.cm. of 20 per cent. sodium taurocholate injected. January 22nd: jelly-like pus was aspirated (30 c.cm.), and 10 c.cm. of taurocholate injected. The temperature was now normal, and smears of the pus showed no organisms, although a few pneumococci were grown. January 23rd: brownish fluid was aspirated (250 c.cm.), and 10 c.cm. of taurocholate injected. Temperature normal and cultures sterile. January 25th: 100 c.cm. of blood-stained fluid was withdrawn. No injection was given. Cultures of this fluid were sterile. The patient was aspirated on two subsequent occasions, and a small quantity of sterile fluid was withdrawn. Radiograms at this time showed "unexpanded lung left base." He was discharged on February 11th, and seen again four weeks later, when he was quite well, and a radiogram showed the left lung practically clear.

We wish to thank Dr. John Menton, county bacteriologist, for his advice and assistance.

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