laparotomy of the usual searching kind, and under field conditions this wastes more than a good hour of time and a great deal of energy.

It soon became apparent to me that no missile ever entered the peritoneal cavity without, by the time the patient reached the surgeon, there being some blood, little or much, in the pelvis. Such did not necessarily imply that a viscus had been injured, only that the abdominal wall had been completely pierced, with some bleeding from it into the general peritoneal cavity. Even without visceral injury there could be a large collection of blood if a particular vessel in the parietal wall had been hit; there was always some. From civil practice one recalls how irritatingly a stab incision through the abdominal wall can bleed until it is tautened on the drainage-tube. The absence of any blood in the pelvis, conversely, meant that the parietal wall had not been pierced.

The Method.—A time-saving, and life-saving, procedure in doubtful cases, based on this fact, seemed justifiable in the conditions then existing. Instead of the usual large laparotomy, turning over of the gut, and palpation of other viscera, a small 1½-in. exploratory incision, halfway between umbilicus and pubis, was made. Through this a swab on a long holder was passed to the pouch of Douglas. If no blood was found on the swab the incision was closed. If the swab was blood-stained the wound was extended into a proper laparotomy, which might or might not reveal visceral injury as well. The small incision was made through the rectus muscle, as any extension necessary then produced what was regarded generally as the quickest and best of abdominal incisions in abdominal injuries—the vertical rectus-splitting. The procedure does not take more than 20 minutes, time for induction of anaesthesia included.

The value of a test depends in great measure on its proper performance and interpretation. It is necessary, for instance, to make sure that the swab on the holder is not soiled on its passage through the small exploratory hole. Again, a purely retroperitoneal injury, perhaps necessitating laparotomy, will of course not give a positive result, but the position of the wound, the signs, and often the odour from it, will not lead one into the performance of the test under these conditions.

While I did not advise the test to be done save under exceptionally busy circumstances, where the greatest good of the greatest number was the prime consideration, it would now be of interest to know of any other experiences in the matter. Personally I have not heard of an instance where a negative finding on the swab did not mean one could shut up the small incision with confidence. While the same thought of the underlying principle must have entered other surgeons' minds, I have found no note of it in the literature, and experienced surgeons of the last war tell me it was not a practice known to them.

Rogers, in the article above referred to, indicates the value of the test in those few cases in which the signs leave doubt as to the advisability of operating, and (a) the amount of shock seems out of proportion to the external wounds, (b) the haemoglobin and red cell count are lower than normal in early cases or the white cell count higher than normal in late cases, and (c) the failure of the patient's condition to improve in a reasonable time.

While I agree with these indications I think they suggest that the doubt arises only in cases of the relatively ill. I would add the occasional case in which the patient is relatively well but his signs are equivocal, and something—call it clinical sense or what you will—leaves the examiner unhappy as to delaying for what may be precious hours. Writers on the subject of abdominal wounds usually record a proportion of negative laparotomies. If, especially in shocked patients, the exploration can be cut down to what is described above, then lives as well as time may be saved.

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J. McConnell (*Amer. J. med. Sci.*, 1945, **209**, 41) describes an outbreak of epidemic pleurodynia affecting young women in a nurses' training school. The source of the epidemic was not determined. Signs and symptoms referable to the central nervous system were usually present. In three patients the symptoms resembled those of meningo-encephalitis. Attempts to reproduce the disease in animals failed.

CASE-FATALITY RATES OF GAS GANGRENE IN RELATION TO TREATMENT*

BY

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The War Wounds Committee of the Medical Research Council recommended in 1940 a combination of measures for the treatment of gas gangrene—the use of surgery and bacteriostatic drugs to control the infection and the use of polyvalent antitoxin to alleviate the toxæmia. At this time the therapeutic value of antitoxin in clinical gas gangrene had not been assessed. It was shown later, by analysis of the case reports on Army Form I 1241 (Macfarlane, 1943), that the fatality rate was significantly lower among patients who received prompt treatment with antitoxin in addition to surgical treatment; even among those who underwent amputation of the affected limb within six hours of diagnosis the beneficial effect of antitoxin was demonstrable. It seemed clear that, in general, the combined use of surgery and antitoxin was more effective in saving life than either of these measures alone, but it was pointed out that patients in whom the gas gangrene involved the thigh or buttock region showed a poorer response to treatment than those in whom the lower leg or arm was affected. This was thought to be due to the difficulty of controlling the infection in a region with a relatively poor collateral circulation and in which surgical elimination of the infection might be difficult or impossible.

In a later memorandum (M.R.C. War Memorandum No. 2, revised edition, 1943) it was recommended that the initial dose of antitoxin should be increased to 50,000 units, given intravenously; it seemed possible that with a more intensive use of antitoxin and with more effective drugs the fatality rate might be further decreased. The case reports from the Central Mediterranean Force have therefore been analysed to assess the effectiveness of the treatment at present recommended, and to examine the factors contributing to death in those patients who died in spite of such treatment. During the period under review penicillin was increasingly used in addition to or instead of sulphonamide drugs, and it is necessary to compare the effect of the combined treatment with and without penicillin before coming to any conclusion on the efficiency of the therapy now available.

Out of a total of 295 reports of anaerobic infections on Army Form I 1241 between the beginning of the campaign in Sicily and June, 1944, 185 reports have been considered to be typical of cases of gas gangrene, the main criterion being the infection of muscle, since bacteriological confirmation of a clostridial infection was not always given. It was shown in an interim analysis (MacLennan and Macfarlane, 1944) that there was good correlation between the data obtained in the early part of the campaign by personal investigations in the field and those obtained from the reports, and a further check is possible by comparison with the report made by Jeffrey and Thomson (1944) on 33 cases of gas gangrene in the C.M.F. treated with penicillin during the early months of 1944.

I. General Features

Method of Analysis.—The difficulties in the evaluation of therapeutic measures in gas gangrene have been discussed previously. Briefly, because of the many variables involved it is necessary to group together cases which are similar in nature and have received similar general treatment and then to determine within such a group the effect of the particular measure to be evaluated. The main facts which must be taken into account are the adequacy of the treatment with surgical measures, antitoxin, and drugs, and the site of the gas gangrene; other factors, such as the general facilities for evacuation and surgery, must also be considered.

Adequacy of Treatment.—The cases have first been grouped according to the level of treatment with surgical measures and

* Based on a report to the Subcommittee on Anaerobic Wound Infections, War Wounds Committee, Medical Research Council.

antitoxin, in the classification used by MacLennan and Macfarlane (1944):

Class I: Treatment within 6 hours of diagnosis, including surgical measures (excision or incisions) and an initial dose of at least 50,000 units of polyvalent antitoxin, given intravenously.

Class II: Treatment later than 6 hours, or with a smaller dose or an intramuscular dose of antitoxin. (Cases in which the route or time of antitoxin dosage was not stated were included in this class.)

Class III: No surgical treatment, or no antitoxin.

This method of classification serves to distinguish in Class I the patients who received the treatment recommended, and the effectiveness of this treatment can be judged by the fatality rate in this class. The treatment in Class II can be broadly defined as being suboptimal in antitoxin therapy, for only 9 of the 78 patients in this class were placed there because of delay in surgical treatment; the difference in the fatality rates of Class I and Class II therefore mainly reflects the effect of prompt intravenous therapy with antitoxin.

Criterion of Adequate Treatment with Penicillin.—The treatment of gas gangrene cases with penicillin was usually systemic. For this analysis the criterion of adequacy has been taken as intravenous or intramuscular injection at the rate of at least 12,000 or 15,000 (Oxford) units every three or four hours. The total dose varied considerably, but the course was usually continued until death in the fatal cases and for three or four days in those which recovered. Some patients received, in addition, local treatment with penicillin, but four receiving only local treatment or an inadequate systemic course have been included in the "No penicillin" group.

It may be noted that the efficiency of the combined treatment including penicillin is being compared with the efficiency of the combined treatment including sulphonamides, and not simply with treatment by surgical measures and antitoxin, for practically all the patients received sulphonamide drugs in addition to or instead of penicillin. Any test of the value of penicillin, as such, in gas gangrene, is therefore bound to be severe, as the effect must be better than that of the sulphonamides in order to be demonstrable.

Site of Disease.—The cases have been grouped in two classes, according to the site of the gas gangrene: Class A, lower leg or arm; Class B, thigh, buttock, shoulder, or back. Approximately Class A is one in which the muscles have a good collateral circulation, and Class B is one in which either the possibility of a collateral circulation is poor or excision is anatomically more difficult.

Conditions for Treatment.—The cases in this series occurred over a period of nearly a year, during which there were considerable changes in surgical teams and in the conditions under which they worked. The high death rate in Sicily and in the early weeks of the Italian campaign may have been due in part to the inexperience of surgeons newly posted, and the rate was in fact falling towards the end of the year (MacLennan and Macfarlane, 1944). During the winter and until the opening of the offensive in May, however, most of the casualties occurred in the Anzio and Cassino areas; the field surgical units were practically in the line, and the conditions for nursing were so difficult that the amount of surgery was necessarily restricted, while the alternative of evacuation by sea or over bad roads was hazardous for patients liable to gas gangrene. Conditions such as these were no doubt mainly responsible for the number of patients in Class III; the disease was established on admission in many of these, of whom some died within an hour of arrival and others were judged unlikely to respond to treatment. The conditions in these areas improved by April, but were clearly inferior throughout to those prevailing during the May offensive. This information is derived from the reports of the Consulting Surgeon, A.A.I., who remarks: "Thus the battle began with an abundance of experienced forward surgeons. . . . The centres were well grouped, and the lines of evacuation short in time and in distance. . . . Never can conditions have been more favourable to good battle surgery."

The change in conditions is relevant to this analysis, for experience and early diagnosis are potent factors in the successful treatment of gas gangrene. In Sicily, and in the early part of the campaign in Italy, penicillin was mainly in the hands of experienced surgeons, since the technique of use was being

explored; it apparently came into general use only during March (almost concurrently with the improvement in general conditions), for after this time approximately 80 to 90% of the reported cases received it. It seems probable, therefore, that the patients who received penicillin were on the whole at least as favourably placed for response to any treatment as those who did not receive it.

Inclusion of Cases with Complications.—The various complications among the 185 cases of gas gangrene in this series fall into two categories—those which may be sufficient in themselves as a cause of death, and those which are more immediately relevant to death from gas gangrene:

1. Complications sufficient as a cause of death:
Head wound, 4; chest wound, 1; abdominal wound, 10; malaria, 2; pneumonia, 1; ? anaphylactic shock, 1. Total, 19 cases (10.3%), with 16 deaths.
2. Complications relevant to death from gas gangrene:
Multiple limb wounds, 33; shock (failure to resuscitate), 4. Total, 37 cases (20%), with 27 deaths.

In three other cases death occurred suddenly, after an initial recovery, from either pulmonary embolism or secondary haemorrhage, which, like renal failure, can be considered as sequelae rather than as complications.

In all, 30% of the cases were recorded as having some complication, but examination of the data shows that the complicated cases are not unequally represented in the different groups, including the groups "penicillin plus" and "penicillin minus," and from a statistical point of view there is no point in excluding such cases from the analysis. The data have therefore been tabulated inclusive of all the cases, but where it seemed of particular interest the rates exclusive of fatal cases with complications have also been given.

Throughout this report a difference is regarded as significant if it exceeds twice its standard error, in which case it would occur by chance less than 5 times in 100 trials. As the number of cases in some of the groups is small, the standard errors are high, and if a difference in rates is to be dissociated from pure chance it would have to be dramatic. It should be borne in mind, therefore, that a difference in rates which is not significant on these numbers might be significant with larger numbers, but is probably not dramatic.

II. Gas Gangrene of Leg or Arm

The data for the patients with gas gangrene of the lower leg or arm are shown in Table I, the cases being grouped according to the class of treatment with surgery and antitoxin, with and without treatment with penicillin.

TABLE I.—Gas Gangrene of Leg or Arm

Class of Treatment	Penicillin			No Penicillin			Difference; $\pm$ S.E.
	Cases	Deaths	Fatality Rate (%)	Cases	Deaths	Fatality Rate (%)	
Class I ..	23	6	26.1	11	1	9.1	- 17 $\pm$ 15
" II ..	8	2	25.0	30	16	53.3	+ 28 $\pm$ 20
" III ..	1	1	100.0	11	10	90.9	- 9 $\pm$ 29

In no case is the difference in the death rate between the two groups, penicillin plus and penicillin minus, statistically significant. In view of the small numbers in Class I, it is of interest to compare the death rates in this class with those of two other groups, reported elsewhere, who received similar but not strictly comparable treatment with surgical measures and antitoxin. The penicillin-treated cases reported by Jeffrey and Thomson (which may overlap to some extent with cases reported on Army Form I 1241) include 12 cases of gas gangrene of the leg or arm. These patients are described as receiving full treatment with surgical measures and antitoxin, including an intravenous dose of antitoxin before or at operation; 11 of the 12 patients recovered. Another series of cases reported previously (Macfarlane, 1943, Table VII) included 24 cases of gas gangrene of the leg or arm treated promptly with surgical measures and antitoxin, with a total dose of more than 20,000 units of antitoxin but without penicillin; 21 of these 24 patients recovered.

It seems clear that in this type of case, given adequate treatment with surgical measures and antitoxin, the expectation of life is high. Many of these patients underwent amputation,

and in view of the fact that in the majority of such cases the infection was eliminated from the body before administration of penicillin was begun it could hardly be expected that this treatment would make a difference to the death rate among them.

TABLE II.—*Amputation Rates in Gas Gangrene of Leg or Arm*

Class of Treatment	Penicillin			No Penicillin			Total in Class		
	Cases	Amptns.		Cases	Amptns.		Cases	Amptns. (%)	Fatality Rate (%)
		No.	(%)		No.	(%)			
Class I ..	23	17	73.9	11	8	72.7	34	73.5	20.6
„ II ..	8	8	100.0	30	27	90.0	38	92.1	47.4

The amputation rate among the 38 patients in Class II (shown in Table II) was over 90%, yet the death rate was 47%; this rate is significantly higher ($27\% \pm 11.3$) than the death rate among the 34 patients in Class I (20%) who received a prompt intravenous dose of antitoxin in addition to radical surgery. The combination of intravenous antitoxin therapy with surgery is clearly beneficial, and in considering its absolute efficiency it is of interest that the 7 fatal cases in Class I all suffered from some complication, which may have affected the issue.

III. Gas Gangrene of Thigh, Buttock, or Shoulder

It was noted previously that the poorer response to treatment in patients with gas gangrene of the thigh or buttock region might be due to the difficulties of excision, and it was certainly hoped that a more extensive use of antitoxin and of drugs highly effective against clostridia would lead to some improvement. The data for the C.M.F. cases of this type (Class B) are set out in Table III.

TABLE III.—*Gas Gangrene of Thigh, Buttock, or Shoulder*

Class of Treatment	Penicillin			No Penicillin			Difference; $\pm$ S.E.
	Cases	Deaths	Fatality Rate (%)	Cases	Deaths	Fatality Rate (%)	
Class I ..	13	5	38.5	11	6	54.5	$+ 16 \pm 20$
„ II ..	8	6	75.0	32	26	81.3	$+ 6 \pm 16$
„ III ..	6	6	100.0	31	31	100.0	No difference

Within each class of treatment with surgical means and antitoxin there was no significant difference in the death rate of the group treated and that not treated with penicillin. The mean death rate in Class I (24 patients, with 11 deaths) was 46% and in Class II (40 patients, with 32 deaths) 80%; the case fatality was therefore significantly decreased ($34\% \pm 12.1$) when the recommended treatment was given, but the death rate in this type of case was absolutely much higher than in the cases with gas gangrene of the leg or arm.

Jeffrey and Thomson (1944) report 18 cases of this type which received treatment with surgical measures and antitoxin similar to Class I, in addition to penicillin; of these patients 8 died—a death rate of 44.4%. In a previous series of cases (Macfarlane, 1943) out of 11 patients of this type who received early treatment with surgery and antitoxin, with a total of more than 50,000 units, 6 died (54.6%). In spite of the best treatment which could be given in these circumstances, the death rate from gas gangrene in these sites remains about 45%.

IV. Conclusions on Effect of Treatment

The reduction in the death rate when antitoxin and bacteriostatic drugs were used as recommended in addition to surgical measures affords a striking testimony to the value of the combined method of treatment. It is clear, however, that the ancillary measures had their limitations in a type of case in which surgical excision of the affected tissue may be impossible. It does not appear that this limitation was due to inadequate dosage with antitoxin. The total dose of antitoxin given within 48 hours of onset to patients with gas gangrene of the thigh or buttock (Class I only) is shown in Table IV; similar figures for the group described by Jeffrey and Thomson are included. The death rates were not significantly less among the patients who received a total dose of more than 120,000 units of anti-

toxin; that is to say, there is no indication that a larger dose would have been of value as a routine.

TABLE IV.—*Dosage of Antitoxin in Class I Cases*

Series of Cases	Total Dose of Antitoxin in 48 Hours						Difference ; ± S.E.
	Up to 120,000 Units			Over 120,000 Units			
	Cases	Deaths	Fatality Rate (%)	Cases	Deaths	Fatality Rate (%)	
C.M.F. Army Forms	11	7	63.6	13	4	30.7	32.9 ± 20.4
Jeffrey and Thomson	9	4	44.4	9	4	44.4	No diff.

With regard to the adequacy of treatment with penicillin the cases included in the penicillin group received a dosage which has been estimated to maintain a bacteriostatic level in the blood. In the C.M.F. cases there was no significant difference in the death rate between those who received penicillin systemically and those who did not, even among cases (Class B) in which a decrease might legitimately be expected if effective chemotherapy could compensate for inadequate surgical excision. This does not imply that penicillin is without value in the treatment of gas gangrene (still less that it is without value in the treatment of the patient, for the question of wound-healing has not been considered). Its value as a specific treatment, in the sense that the death rate was lower among those treated, is simply not proved. Whether penicillin controlled the bacterial infection is another matter, and one difficult to assess when several measures were often employed. It seems possible, however, that in a disease in which there is frequently a failure of the circulation through the infected area the local application of penicillin might be the more effective route.

The doses of antitoxin and drugs used appear to be adequate for their purposes and, on the whole, the opinion of surgeons seemed to be that the clostridial infection was controlled. If this was the case the question arises whether other factors were contributing to death in those patients who died in spite of apparently adequate treatment of the infection. In a number of cases the immediate cause of death was renal failure rather than a fulminating toxæmia, and the similarity between this type of case and the crush syndrome was pointed out by Jeffrey and Thomson. It is surely significant that the specific treatment recommended for gas gangrene was highly effective in a type of case in which radical excision was almost always carried out, and much less effective in a type in which excision was sometimes limited in extent. The hypothesis that a toxic substance is absorbed from muscle damaged by trauma or ischaemia is of course not new, but lately, with the recognition of the crush syndrome and the occurrence of massive limb wounds, it has aroused much interest. It is not unlikely that a necrotic bacterial toxin, such as *Cl. welchii* alpha-toxin, might accelerate or augment the liberation of a "muscle toxin" and thus have a potent secondary effect in addition to any direct action on a vital organ. In most cases the danger from such an effect would be minimized by early excision, but where excision is delayed the prevention of local damage may be of great significance. The existence and the nature of such a "muscle toxin," however, have yet to be demonstrated.

The importance of surgical excision of the affected tissue in gas gangrene has long been recognized, but as emphasis has been laid on this procedure chiefly in order to control the infection it seemed possible that bacteriostatic drugs might lessen the necessity for radical surgery. If the resorption of some toxic substance other than the bacterial toxin from gangrenous muscle is a factor in the severity of gas gangrene the situation is changed. On the one hand, if radical excision is practised the drug is probably superfluous as a life-saving measure; on the other hand, if the necrotic muscle cannot be removed and is a source of danger the drug may in fact control the infection—which is its virtue—without altering the outcome of the disease. To mention this possible limitation is of course not an argument against the use of drugs, for the control of the infection by any possible means is a primary necessity; but it may account for the fact that, with the numbers available, it has not been possible, either with the sulphonamide drugs or with penicillin, to show in the statistical sense that the drugs increased the expectation of life.

Summary

In a series of 185 cases of gas gangrene in the C.M.F. reported on Army Form I 1241 the case-fatality rate has been examined in relation to the treatment given. The combined method of treatment with surgical measures, intravenous antitoxin, and bacteriostatic drugs, when given as recommended, was highly effective in reducing the death rate in cases with gas gangrene of the leg or arm. The death rate in cases of gangrene of the thigh, buttock, or shoulder region was approximately 40% in spite of such treatment, even among those who received penicillin systemically. The findings suggest that the specific treatment was generally effective in controlling the clostridial infection, but that in cases in which surgical excision of the affected tissue is limited in extent some factor associated with the local damage to muscle may be contributing to the severity of the disease.

Thanks are due to the Director-General, A.M.S., for access to the reports. I am also indebted to Dr. E. Lewis-Fanning for his criticism and the verification of the statistical significance, and to Sir Claude Frankau, Mr. B. W. Williams, and Prof. McIntosh for their comments on various case reports.

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STAPHYLOCOCCAL PYOPERICARDIUM (COMPLICATING TYPHOID FEVER) TREATED WITH PENICILLIN

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Because penicillin has been scarce, and because repeated injections are exceedingly trying to a debilitated patient, it is the rule that local application, whenever this will suffice, should be used in place of systemic treatment. It is recognized, too, that the use of penicillin does not in any sense replace surgical drainage, and that when pus is formed in any quantity it must be evacuated. In the case here described a staphylococcal infection of the pericardium supervened in the course of a very severe typhoid infection. The ensuing pyopericardium was successfully treated by the repeated aspiration of pus and the instillation of sodium penicillin into the pericardial sac.

Case History

An officer cadet, aged 26, was admitted to a military hospital on May 25, 1944, complaining of malaise, nausea, abdominal pain, and constipation for three days. On admission the temperature was 104° and the pulse rate 96. Apart from slight abdominal distension, no definitely abnormal physical signs were present. The urine was normal, and the white cells numbered 4,500 per c.mm. with a normal differential count. Health in the past had been unexceptionable. The most recent immunization with T.A.B. vaccine was in March, 1944.

The patient remained acutely ill, with high sustained fever. The abdominal distension became more marked and a troublesome cough developed. On May 29 *B. typhosus* was isolated from the blood in pure culture. About the same time a scanty macular rose-spot rash appeared on the abdomen. During the next few days his condition still further deteriorated. Constipation gave way to a persistent diarrhoea, with which vomiting was associated. The patient became stuporous and delirious. By June 4 serious dehydration was apparent, and three litres of normal saline were given by intravenous drip. Abdominal distension was pronounced, and there was considerable basal congestion of both lungs. But the fluid was well tolerated, and its administration was followed by a great improvement in condition.

By June 14 the temperature had practically settled, only a negligible evening rise persisting. Progress at this time appeared very satisfactory, but, disappointingly enough, four days later the patient again became seriously ill. The temperature was now 102°, and the pulse, weak and irregular, was 128. The physical signs were typical of a pericardial effusion, there being a definite paradoxical pulse and a positive Ewing's sign. On June 24 the pericardium was needled in the fifth intercostal space, half an inch inside the area of cardiac dullness; 50 c.cm. of thin pus was aspirated. This pus gave a pure growth of *Staph. aureus* on culture. The next day

surgical drainage of the pericardium was attempted. A trephine hole was made through the sternum at the level of the fourth cartilage, but pus was not found in the pericardial sac. It was thought that this was due to the aspiration of the pericardium on the previous day.

On June 26 it was decided to needle the left pleura. Pus was not found, and the physical signs at the base of the left lung were those of collapse. The white cell count was 26,600 per c.mm., with an excess of polymorphs. The haemoglobin was 64%. The next day the pericardium was again explored through the trephine hole, and on this occasion pus was found and 4 oz. was evacuated. One pint of fresh blood was given by intravenous transfusion.

The pathologist had now reported the sensitivity of the *Staph. aureus* isolated from the pus withdrawn from the pericardium as being approximately the same as that of the standard "Oxford" *Staph. aureus*—i.e., zones of inhibition around cups containing one Oxford unit of penicillin per c.cm. were as follows: (1) patient's staphylococcus, 19 mm.; (2) Oxford staphylococcus, 28 mm. On June 28, therefore, penicillin therapy was inaugurated, 50,000 units of sodium penicillin being injected direct into the pericardial sac by means of a No. 5 rubber catheter. The superficial part of the operation wound had become secondarily infected, culture giving a profuse growth of *Ps. pyocyanea*. Before catheterization, therefore, the wound was filled with 1/1000 perchloride of mercury for a few minutes and then swabbed dry. This technique was found satisfactory, and there was no difficulty in the repeated passage of the catheter. The penicillin was introduced after aspiration of as much pus as possible and the wound subsequently packed to prevent leakage. The injection of 50,000 units was repeated on five further occasions, giving a total dosage of 300,000 units. The first three injections were given on successive days, and the last three on alternate days. After the third dose of penicillin the pus withdrawn from the pericardial sac was reported as sterile on culture.

On July 1 there was considerable improvement in the clinical condition. This improvement was maintained in spite of a sharp attack of diarrhoea, which responded satisfactorily to sulphaguanidine therapy. By July 10 the temperature was once again normal. On this day a further pint of blood was transfused. The haemoglobin prior to transfusion was 70% and the white cell count 14,500 per c.mm.

On July 17, however, there was a renewal of the fever, with the temperature rising to 102°. Some abdominal distension was still present and the pulse was again markedly paradoxical. The spleen was felt "two fingers" below the costal margin, tenderness and rigidity were noted over the right upper abdomen, and there were physical signs of a considerable effusion in the right chest. It was clear that fluid had once again accumulated in the pericardium, and 20 c.cm. of thin sterile pus was aspirated from it. Eighteen ounces of clear yellow fluid, sterile on culture, was also withdrawn from the right pleura. Some improvement followed this, but in view of increasing dyspnoea it once again became necessary to aspirate both pleura and pericardium, 15 oz. being withdrawn from the former and 15 c.cm. from the latter.

By Aug. 2 there was still an evening rise of temperature to about 100°. Signs were now apparent of fluid in the left chest, and 12 oz. of sterile heavily blood-stained fluid was aspirated. The spleen could still be felt and the liver was palpable one inch below the right costal margin. Slight oedema of the ankles was noted. Further exploration of the right chest produced only 3 c.cm. of fluid. No more could be obtained.

On Aug. 17 the patient was again transfused. In view of the persistent pyrexia a course of systemic penicillin was given, 15,000 units being injected every three hours for three days. This produced no improvement in the clinical picture, and it was abandoned, as it was proving very exhausting. At this time another 14 oz. of blood-stained fluid was withdrawn from the left chest. The white cell count had dropped to 10,000 per c.mm., the haemoglobin was 75%, and the red blood cells 3,650,000 per c.mm. The general condition had improved. The blood pressure was 110/75, with no paradoxical pulse or evidence of cardiac tamponade. The liver and spleen were no longer palpable, nor was there reaccumulation of the pleural exudates.

The evening rise of temperature still persisted, and there now developed a very tender swelling over the lower left costal cartilages. A diagnosis of typhoid periostitis was made, and on Sept. 7 operation was performed under local analgesia, a transverse incision being made over the costochondral junction. Thickened inflamed tissues were found with a small quantity of pus beneath the periosteum. The bone was curetted and drained and the wound packed with vaselined gauze. Thereafter convalescence was slow but consistent. By Oct. 10 the patient was well enough for repatriation to the United Kingdom by hospital ship.

Comment

The occurrence of a staphylococcal pyopericardium in the case of a soldier already gravely ill with typhoid fever is