maternity hospital, so that the problems of the neonatal period are not forgotten. The institute should also be closely linked with the university on the one hand and the regional or public-health authority on the other.

Institutes would not normally concern themselves with the treatment of the individual sick child: they should be centres for training and research in preventive medicine, the growth, development, and aptitudes of children, and in epidemiology; they should be the regional pædiatric centre—for example, medical advisory committees on child health, set up as part of the new health service, should meet there. Clinics for children whom it is not desired to bring into a hospital outpatient department, with its risks of infection, should be held there. Model welfare clinics, clinics for tuberculous contacts, psychiatric clinics, remedial exercise clinics, and so forth should be housed in the institute building, besides research and follow-up clinics for any special problems.

Information should be readily available at the institute concerning the health and infectious diseases of the area, so that clinicians may be kept alive to the problems of the public-health administrators, and may constantly see their work for individual patients in relation to a larger whole. Doctors and nurses, working in the different branches of pædiatrics, should look on the institute as the recognised centre for conferences on practical problems in child health, such as an epidemic in the local schools or neonatal mortality in the area; and courses of postgraduate training might be held there. The institute should also possess a good reference library.

The institute for child health should be staffed by specialists from the children's hospital, by administrative heads of the child-welfare and school medical services, by doctors and nurses engaged in clinical work in schools and welfare centres, and also by doctors and nurses in training for pædiatric work. Other specialists, such as obstetricians, epidemiologists, statisticians, and nutrition experts, should also be members or associate members of the staff. The specialist staff of the children's hospital, who are responsible for teaching, would gain from their contacts with the health administration, and the administrators could get help in their work from the specialists; and general practitioners engaged in pædiatric work should join with both in working out problems.

New prospects of research would be opened up. Suppose, for instance, a doctor at a health centre, who was also medical officer to a school, wished to carry out an investigation at the school and needed the help of a laboratory or other special service, such as a psychiatric or X-ray department, it should be possible for him to unite with other workers and for them jointly to bring their scheme to the notice, say, of a committee of the Medical Research Council. If this committee viewed it with favour, they would recommend that the practitioner be enabled to devote some of his time to the investigation. If the doctors at the health centre were paid by salary considerable elasticity should be possible in such matters once the present acute shortage of doctors is overcome. Or again research might be initiated from the other end: if a medical administrator or a medical or surgical specialist wished to follow up a special group of cases, the coöperation of selected clinicians at the centre might be invaluable, and the same machinery could make it possible for them to give time to the undertaking.

DISCUSSION

In the scheme I have outlined, which I do not claim as in any way original, the main medical care of children, including domiciliary work and group medicine in schools and welfare centre, would be done by doctors and nurses, attached to health centres, who are interested in, and have been specially trained for, this branch of medicine—a branch which offers the best prospects to the individual doctor of improving health. This change cannot be effected quickly, for we have not enough doctors and nurses trained for the work, but a start could be made immediately at experimental health centres. These doctors should possess postgraduate training in pædiatrics, and would be provided with opportunities of keeping their knowledge up to date by contacts with the key children's hospital and with the associated institute of child health. This institute would be linked both with the university and the local or regional authority and should form the centre of coöperation for all doctors and nurses engaged in service for children—as a place of training in preventive pædiatrics and as a place for increasing our understanding of child health. As knowledge of how to promote health involves knowledge of lack of health and of illness, I hope for the closest association between the children's hospital and the institute, as well as between pædiatricians, pædiatric general practitioners, pædiatric surgeons, obstetricians, children's nurses, and trained medical administrators.

I have talked of a utopia where lions and lambs, or, let us say, administrators and clinicians, lie down together. I have not told you how we are to reach this happy state, and I know it will not be easy; but we have plenty of idealism and plenty of common sense to help us. It is up to us to see the goal ourselves, and to get others to see it so that we may start on the way, even though the goal may not be reached in our life-time. The will exists to give children the best health we can, and the opportunity to reorganise and extend our medical services in their interest is upon us. May we, doctors and public, Government and profession, use it to the full.

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ACUTELY INFECTED PLEURAL EFFUSIONS
TECHNIQUES OF PENICILLIN TREATMENT

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THE techniques described below have been used with penicillin in the treatment of 24 acute infected pleural effusions: 14 while their pneumonic symptoms were still present and 10 after this phase had subsided. The success or failure of each technique was assessed by comparison of the results with those in a series of 14 controls, treated and observed from the pneumonic stage and taken in strictly alternate chronological order with the first group of the penicillin cases. These controls were treated along well-accepted lines, as the course of their condition indicated, so their results are a fair standard against which to measure those obtained with penicillin. For this purpose the duration of illness both from earliest pneumonic symptoms and from drainage till full healing in each penicillin case ("treated") was compared with the means of the controls, which were 15·0 and 11·6 weeks respectively.

The following criteria were then adopted. Any "treated" case taking as long as these means for full

* With a grant from the Medical Research Council.

healing was considered a "failure." Treatment was accounted "successful" only when the duration was less than the shortest time taken by any of the controls—i.e., 8·5 weeks from earliest pneumonic symptom, and 5 weeks from drainage (control cases 1 and 14). "Partial success" is defined in the text.

ASPIRATIONS FOLLOWED BY INJECTIONS OF PENICILLIN

There were 7 cases: 2 pneumococcal, 2 staphylococcal, and 3 streptococcal. The results were: 2 successes, 1 partial success, and 4 failures.

The 2 successes were with interlobar collections of not more than 2 oz. One was a purulent staphylococcal effusion in a very ill child aged 7 years (case 1) and the other a pneumococcal collection in a man aged 40, six weeks after the onset of his pneumonic symptoms (case 15). Both received injections following aspiration every second day, till no further fluid could be aspirated, the treatment lasting eleven and seven days respectively. Though no exact end-point can be gauged in these cases, their erythrocyte-sedimentation rates had fallen from the region of 90 to under 20 per hour (Westergren) within 3½ weeks of first treatment, and both patients were then up and feeling well. The benefit of starting treatment early was demonstrated by the fact that the total duration of illness, till no further fluid could be aspirated, in the seriously ill case was 4 weeks, whereas the long preliminary period before treatment was begun in the second lengthened his illness to 8½ weeks.

"Partial success" was recorded in one large streptococcal effusion where no attempt was made to aspirate the full contents of the pleural cavity (case 2). Here thickening of the fluid did not develop to an appreciable extent; but, though sterilisation of the fluid, elimination of gram-positive cocci, and apyrexia were secured by the end of seven days, the functional result was not satisfactory. Fluid persisted for about six weeks, and flattening of the chest, with diminished expansion, remained obvious for many months.

The 4 failures (cases 3, 8, 12, and 13) were in infections with each of the three types of bacteria. They were large empyemata in which the originally thin fluid thickened so considerably that aspiration was almost impossible.

Though the effusions were sterile on culture and lessened considerably in amount, pyrexia persisted, and the time—2½–3½ weeks—during which this treatment was persisted in enabled a firm cavity with resistant walls to form, preventing full lung expansion. Three were subsequently drained.

A death took place in this group in an infant aged 3 months (case 3). The child already had anasarca when first treated on its 8th day of illness. It died suddenly at the end of a week's treatment, after some progress appeared to have been made, and at autopsy multiple staphylococcal lung abscesses and fibrinous pericarditis were found.

This method was abandoned early in the series except for small interlobar effusions which could be completely emptied by aspiration.

RIB-RESECTION

There were 3 cases: 2 due to hæmolytic and 1 due to anaerobic streptococci. All 3 were failures.

Two of the rib-resections followed aspiration and injection of penicillin (cases 12 and 13), and one followed intercostal drainage of one loculus of a multiloculated empyema (case 14). In every instance at the time rib-resection was carried out the pus was sterile on culture.

Penicillin therapy was not continued immediately in 2 cases. In case 13 the wound was sewn up round a Tudor Edwards tube, and further local administration alternating with drainage continued. All 3 cases became secondarily infected with *Staph. aureus* after treatment had been discontinued. The suppurating sinuses of 2 cases (12 and 13) were subsequently packed daily with gauze soaked in penicillin paste till wound swabs became sterile. The sinus mouths were then covered with a dry dressing—without drainage tube—and left rigorously alone for a week. By this time their mouths were closed and no further recurrence took place. Case 14 was treated along the same lines as the controls, but his sinus took eight weeks longer to heal than did those of the two other cases.

The total lengths of illness and time from drainage were of the same order as those of the controls. This method of treatment was abandoned completely as soon as it was realised how badly these cases were progressing compared with others treated by the methods subsequently described.

INTERCOSTAL DRAINAGE AND INSTILLATION OF PENICILLIN

There were 10 cases: 7 pneumococcal, 2 staphylococcal, and 1 anaerobic streptococcal. The results were: 7 successes, 2 partial successes, and 1 failure. This method depended on the alternate use of the intercostal tube for drainage and for instillation of penicillin.

The 2 cases in which there was partial success had to have subsequent aspirations after healing had taken place—of sterile pus and of fluid containing *Bact. coli* respectively. In one case the drainage was at fault, in the other, a patient aged 61 with auricular fibrillation and well-marked scoliosis, the inability of the lung to expand and fill the residual space favoured the collection of exudate (cases 23 and 18).

The only failure (case 14) was associated with faulty technique, a multiloculated empyema being drained from one loculus only. Rib-resection was carried out eventually. Two later similar cases have been treated successfully by draining each separate loculus either synchronously or consecutively.

All these cases, except the failure, were healed in 6–7½ weeks from first symptoms and 2–4½ weeks from drainage. This method was found most suitable for localised empyemata; there was little risk of collapse of the lung at this stage, and emptying of the cavity was far more effective than by aspiration, once the exudate had thickened.

ASPIRATIONS AND INJECTIONS WITH SUBSEQUENT INTERCOSTAL DRAINAGE

There were 8 cases: 6 pneumococcal, 1 staphylococcal, and 1 pneumococcal and non-hæmolytic streptococcal. The results were: 7 successes, 1 partial success, and no failures.

In this group aspiration and injection were carried out for a preliminary period followed by an intercostal drain when the exudate thickened. The time during which aspiration was carried out varied, but it was realised, before the investigation was completed, that it had been unnecessarily long in most cases. These cases were healed in 5–8·5 weeks from first symptoms and 2–4½ from drainage, except the partial success in a child aged 4 years who developed Sönne dysentery and whose treatment was interrupted for a fortnight.

This method of treatment was found eminently suitable for the effusions first treated in the toxæmic phase—in other words, it was the method of choice for all cases, provided they were detected and treated early enough, because in these the lung expanded readily, obliterating the cavity, and there was no loculation of fluid.

Techniques Recommended

The evolution of the final techniques depended on the discovery during the investigation of the following basic findings.

For the "treated" series:

(1) That injection of a large enough dose of penicillin into the pleural effusion would not only ensure treatment of the local condition, but also provide a systemic concentration for periods of 24–48 hours, according to the size of the dose given: 120,000–240,000 units. for adults, 1000 units per pound of body-weight per 24 hours for children under 5 years (Florey and Heatley 1945).

(2) That sterile cultures from pneumococcal and streptococcal effusions were by no means a reliable guide to the elimination of infection and thus an indication for cessation of treatment. Films from which gram-positive cocci had entirely disappeared were of very much greater value in this connexion. Study of the changes taking place in films was the most reliable early guide to progress in the control of infection (Fatti et al. 1946).

(3) Radiological evidence, apart from definite fluid levels, was not a sole criterion on which to rely for the discontinuance of drainage (Fatti et al. 1946).

For both series:

(4) That the risk of secondary infection of the pleural cavity following surgical drainage was considerable, and that it was a factor in prolonging suppuration and healing time (Fatti et al. 1946).

The most satisfactory techniques used were those described below.

THIN EFFUSIONS IN THE TOXÆMIC PHASE

When exploration for fluid is first carried out, penicillin is placed, ready for use, on the dressing-trolley.

Aspiration is carried out when fluid is found and as much as possible is removed without distressing the patient, the last 10 c.cm. being reserved for bacteriological examination.

Penicillin 240,000 *units* (or 2000 units per lb. body-weight in children under 5 years) in 20 c.cm. of saline is injected into the cavity slowly, care being taken to see whether the patient coughs up any yellow stained sputum as evidence of a bronchopleural fistula. The injection is done without waiting for the bacteriological report; but, if the report indicates that the fluid is infected, treatment is repeated every second day till the effusion is frankly purulent.

An *intercostal drain* is then inserted at the most suitable site for drainage. An incision is made in the skin only, and a trocar and cannula are used for penetrating the pleural cavity, so that the insertion shall be as airtight as possible.

The method of replacing the trocar by a drainage tube is demonstrated in fig. 1, its efficacy depending on the use of a drainage tube which exactly fits the bore of the cannula. No suture is employed, as this tends to cause some sloughing, and the tube may need readjustment later so that its mouth is at the correct level to ensure complete emptying of the cavity. If many fibrin clots frequently block the tube, the cavity is washed out with saline, but this is only done in the theatre, where every aseptic precaution can be observed. The use of a sucker often obviates the necessity of a washout and appears to be the most effective method of emptying the cavity. The cavity is left to drain under a water-seal over night, if the patient has passed the toxæmic stage. If not, an instillation is given as soon as all pus appears to have been removed (fig. 2).

Instillations following drainage are given into the tube twice a day, after the tube has been disconnected from the drainage system. Care is taken to pinch or clip the tube before disconnexion, to prevent any ingress of air. A solution containing 500 units of penicillin per c.cm. is sufficient if the toxæmic phase is past, as is usual in pneumococcal and streptococcal infections. The volume instilled is half the amount of discharge that has drained away, up to a maximum of 20 c.cm. This injunction depends on the ensurance of free drainage. For staphylococcal infections a systemic dose of 60,000 units is instilled twice daily, or the equivalent of 500 units per lb. body-weight in children under 5 years. The 24-hour dose is divided in two to compromise with the necessity for draining. After instillation a spigot is placed in the mouth of the drainage tube, and the tube is strapped to the chest wall (figs. 3 and 4).

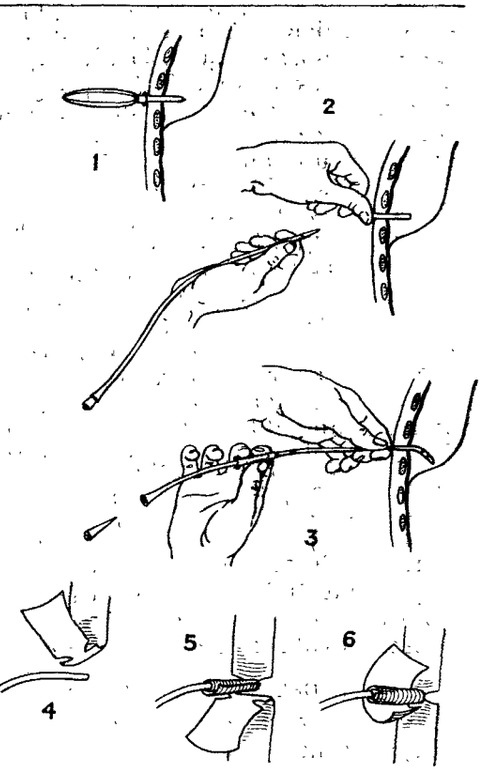

Fig. 1—Method of setting up intercostal drainage: (1) trocar and cannula inserted into pleural cavity through small incision through skin and subcutaneous tissues; (2) mouth of cannula blocked with thumb till well-fitting drainage tube is inserted while spigoted; (3) removal of cannula while air is prevented from entering pleural cavity by firmly gripping tube close to chest wall; (4) 'Elastoplast' cut to fit round and attach tube to chest wall; (5) second strip cut similarly; (6) third strip to hold the other two firm on tube. Tubes attached in this way have remained in situ 10 days in patients who were not restless.

Drainage is set up twice a day by connecting with the underwater system an hour before each instillation. Usually, unless the tube has become blocked, the whole amount that drains is expelled in 10 minutes, but the longer period is recommended as being safer.

A *radiogram* is taken on the day after insertion of the intercostal drain, to find out whether the tube is in the right position, and whether there is any residual effusion in the cavity. The radiogram should be taken after the cavity has been drained and not while the instilled penicillin is still in situ. Even 10 c.cm. makes a distinct shadow on the film and may simulate a much larger collection if the cavity is reduced in size and flat anteroposteriorly.

Discontinuance of drainage and instillation is indicated when the pus has disappeared and the discharge is serous or only slightly turbid and watery. *Three serial bacteriological examinations* at this stage are made on separate days. If all three are free from gram-positive cocci both in film and culture, the drainage tube is removed, a final instillation up the sinus being made as it is withdrawn.

A *dry dressing* is then placed over the mouth of the sinus. It is fixed firmly in place and left strictly alone for 5–7 days, by which time the wound should be dry.

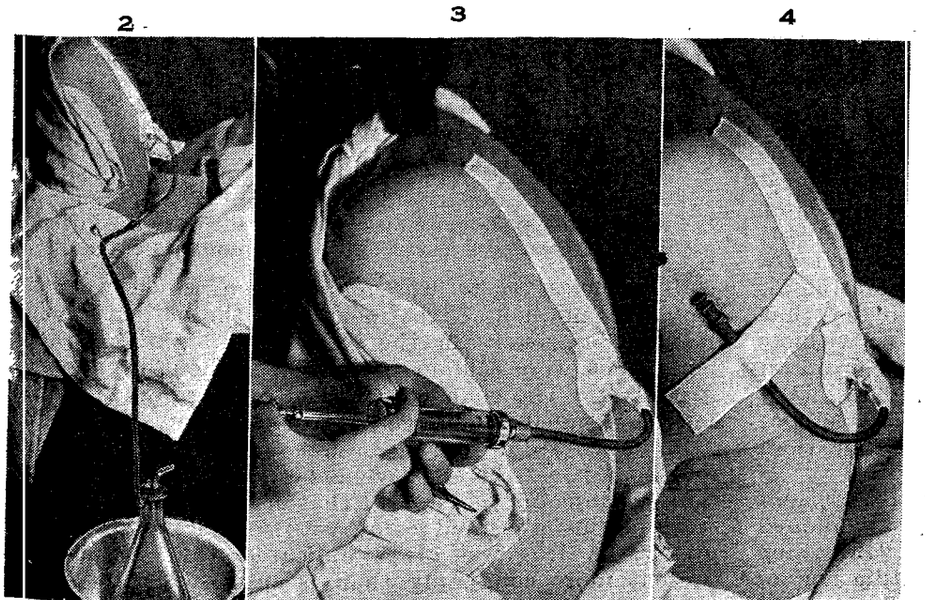

Fig. 2—Intercostal tube connected with underwater drainage system. This lasts an hour.

Fig. 3—Injection of penicillin after disconnexion of tube from drainage system. Nozzle of syringe fits into adaptor to accommodate it to bore of tube.

Fig. 4—Position of tube attached to chest wall after injection of penicillin. This is maintained for 11 hours.

If it remains wet or the granulations pout, a further bacteriological examination is advisable, as a secondary invader may have infected the sinus track and need immediate treatment by instillation.

Breathing exercises are begun the day after drainage has been set up, and the patient is constantly urged to practise them frequently and not only when the physiotherapist is there to instruct him. Great emphasis is laid on this part of the treatment because, with so small an outlet as an intercostal drain, drainage requires to be actively assisted, and because, at the relatively early stage at which these effusions are drained, the lung is usually expansile enough to obliterate the cavity even in the 10–14 days during which drainage is carried out.

Washouts should be avoided unless there is such a mass of fibrin present that the tube is constantly getting blocked. If they must be used, an aseptic technique as rigorous as that used in the theatre must be adopted to avoid secondary infection by penicillin-insensitive organisms.

If these procedures are followed, the period of aspiration and injection lasts about a week, drainage 10–14 days, and full healing of the sinus another week or 10 days, the total duration of treatment from first detection till full healing being 4–6 weeks.

EFFUSIONS WHICH ARE ALREADY PURULENT

Purulent effusions are best drained immediately, before the fluid becomes too thick to pass readily down the intercostal drainage tube. In pneumococcal cases, if the effusion is not diagnosed until it is frankly purulent, the probability is that infection has passed its acute phase, and a dose of penicillin (500 units per c.cm.) producing only a local effect has been found sufficient. In the staphylococcal cases, however, the patients are very toxæmic and require a systemic dose (60,000 units twice daily).

SMALL CAVITIES

When the cavity is small and bounded by the yielding walls of an interlobar space, treatment by aspiration and injection alone has proved sufficient. Emptying of such a space by this means is possible, but it is seldom so when the effusion extends down to the diaphragm and is largely bounded by the resistant outer wall of the chest. Aspirations are carried out every second day, this being as often as most patients can face them with equanimity. A systemic dose is administered (240,000 units), for without the help of daily drainage it is necessary to ensure constant bacteriostasis in and around the walls of the cavity as well as in the effusion itself. The indications for discontinuing treatment are those already described.

Discussion

Papers have already been published describing the treatment of empyema with penicillin (Florey and Florey 1943, Keefer et al. 1943, Tillet et al. 1944, Bennett and Parkes 1944, Lockwood et al. 1944, Butler et al. 1944, Herrell and Kennedy 1944, Roberts et al. 1945, Healy and Katz 1945, Rudensky et al. 1945, Hirshfeld et al. 1945). The consensus of opinion seems to be that aspiration and injection with penicillin, with or without simultaneous intramuscular injections, may clear up an empyema, but that the pleural thickening and resultant diminished respiratory reserve following long persistence in this treatment cannot be overcome by other than standard methods of surgical treatment.

Roberts, Tubbs, and Bates (1945) attempted treatment by instillation after rib-resection, but this was abandoned as being ineffective. Hirshfeld and others (1945), using an intercostal drain, also abandoned instillation of penicillin after a week's treatment. d'Abreu and his colleagues (1944), however, described the satisfactory use of instillation alternating with intercostal drainage in a case of pyopneumothorax as a preliminary to removal of an intrathoracic foreign body. The purpose of this paper is to demonstrate that a technique can be used which combines effectively two essentials of treatment of an infected effusion—the use of an antibacterial agent and drainage—and causes minimal discomfort to the patient.

The standard set for successful treatment was high, but 18 of the 20 cases treated along the lines recommended came up to it—in other words, none of the 14 cases treated by standard methods of drainage alone was healed in so short a time as any of these. Though the stage at which an effusion was detected and treated by aspiration or drainage varied from 1 to 3½ weeks after earliest pneumonic symptoms, undoubtedly the earlier the effusion was detected and penicillin treatment started the shorter the total duration of illness. There is good reason to hope that the figures in the accompanying table can be reduced as soon as this is commonly realised and cases are not only treated at the earliest possible moment after fluid is detected, but also are referred early to the surgeon. These points need to be emphasised, for there is no indication that chronic empyemata which have persisted for a year or more will respond to the treatment outlined here. More radical surgical measures are then undoubtedly required, and it is to avoid these that the surgeon should take over as soon as the intercostal drain is indicated.

The choice of dosage was regulated by two considerations:

(1) The necessity for maintaining a bacteriostatic concentration in all tissues that might be infected beyond the immediate vicinity of the pleural exudate—i.e., 240,000 units every 48 hours or their equivalent for shorter periods.
(2) The desire to find the smallest dose compatible with good effects. With supplies of penicillin steadily mounting, the second consideration should be of academic rather than practical consequence in the future. There is no necessity, except for reasons of economy, to reduce the dose at any time, but it is well to remember that, once the infection is well localised, so small a dose as 5000 units twice daily, combined with good technique, will effect the same results as one twelve times it size.

Aspiration was preferred to drainage for two reasons:

(1) That with aspiration continuous retention of the drug was assured, and so systemic treatment could be more satisfactorily carried out. Instillation of systemic doses via an intercostal tube did not produce bacteriostatic levels in the blood-stream for such constant periods as did this method. This may have been due to some waste or to some of the dose being retained within the tube and so not being absorbed.
(2) That, no matter how carefully the intercostal tube was inserted, the frequent interference for instillation and connexion with the drainage system favoured the introduction of air and the collapse of lung, and prevented the fluid instilled from coming in contact with the whole of the affected pleural surfaces. Aspiration can effectively remove air as well as fluid, so that any remaining cavity will fill with its own exudate and so distribute the injected penicillin more or less evenly throughout its extent.

Nevertheless there was no question which was the preferable method of treatment from the patient's point of view, especially in the case of children on whom aspirations were seldom performed without crying and struggling. The change-over was therefore made at the earliest moment conducive to good treatment.

It might seem that a bronchopleural fistula would militate against the effectiveness of treatment by aspiration and injection. The fact that in 9 out of the 24 cases treated sputum stained yellow with penicillin was coughed up as the drug was given indicated that fistulæ are present more commonly than is supposed. In spite of them the treatment was effective. Injections given more frequently than once in 48 hours might be recommended in these patients, who may cough up a fair proportion of the drug and so not maintain continuous bacteriostasis in the blood-stream.

RESULTS WITH DIFFERENT TECHNIQUES

Method of treatment	Controls							Treated with penicillin						
					Duration (weeks)							Duration (weeks)		
	Case no.	Age (yr.)	Size of effusion (oz.)	Infecting organism	Symptoms before detection	Onset to healed	Drainage to healed	Case no.*	Age (yr.)	Size of effusion (oz.)	Infecting organism	Symptoms before treated	Onset to healed	Drainage to healed
Aspiration only ..	1	52	2	Pneum.	3·5	8·5	..	1	7	1	*S. aur.*	1	4	..
								2	37	20	H. strep.	3	7·5	..
								15	40	2	Pneum.	7	8·5	..
								3	3/12	1·5	*S. aur.*	1	Died	..
Intercostal drainage following aspiration	2	12	26	*S. aur.*	1	11	10	4	1	2	*S. aur.*	1	5·5	2
								16	74	5	Pneum.	1·5	5	3·5
								5	46	15	Pneum.	1·5	7	4·5
								6	6	5	N.-h. strep. and pneum.	1·5	7·5	3
								7	64	14	Pneum.	1·5	8·5	4·5
								17	47	14	Pneum.	2	6	2·5
								8	52	22	Pneum.	2	8	3·5
								9	4	?	Pneum.	2·5	10	7·5
Intercostal drainage only	3	7	12	Pneum.	2·5	10·5	7·5	10	3·5	5	*S. aur.*	2	6	4
								11	31	2	Pneum.	2	6·5	4·5
								18	61	34	Pneum.	3	6‡	3
								19	4	2	Pneum.	3·5	7	3·5
								20	8	2	*S. aur.*	3·5	6·5	3
								21	74	6+6	Pneum.	3·5	7·5§	4
								22	7	8	Pneum.	4	7	3
								23	40	10	Pneum.	4·5	7·5‡	2
								24	40	3	Pneum.	4·5	7·5	3
Rib-resection:														
after aspiration	4	7	40	Pneum.	1	>63	>60	12	53	20	H. strep.	1·5	13	10
	5	42	15	Pneum.	1·5	10	6	13	21	20	H. strep.	2	17	11·5
after aspiration and intercostal drainage	6	16	26	H. strep.	2	15·5	12	..	..	..	..	..	..	..
	7	39	40	?†	2	15	11·5	..	..	..	..	..	..	..
	8	46	14	N.-h. strep.	2·5	23	18	..	..	..	..	..	..	..
after intercostal drainage	9	1	1	Pneum.	1·5	>17	>12	14	43	15	Anaer. strep.	2·5	22‖	19·5
	10	6	32	H. strep.	1·5	24	22·5	..	..	..	..	..	..	..
	11	27	38	H. strep.	2·5	23	20·5	..	..	..	..	..	..	..
rib-resection alone	12	13	4	*S. aur.*	1	15	8	..	..	..	..	..	..	..
	13	32	5	Pneum.	2	12	6	..	..	..	..	..	..	..
	14	6	?	Pneum.	2·5	10	5	..	..	..	..	..	..	..
Means¶	..	..	..	..	..	15·0	11·6	..	..	..	..	..	7	3·6
Standard deviations ..	..	..	..	..	..	±4·94	±5·77	..	..	..	..	..	±1·34	±1·26

* Nos. 1–14 treated alternately with controls. † Gram-positive and gram-negative cocci and bacilli in films, but culture sterile.
‡ 2 subsequent aspirations before chest cleared. § 2 loculi drained consecutively.
‖ Multilocular empyema not drained from each loculus before treatment discontinued.
¶ Case 4 excluded from controls because of error in treatment, case 3 from "treated" because of untreated attendant exudative pericarditis, and cases 12, 13, and 14 because surgical treatment not recommended.

Even when the effusions were not located—a circumstance which every experienced clinician knows is by no means uncommon—injections were made into the pleural space, though no appreciable fluid was withdrawn. These had a well-marked effect on the toxæmic signs, though they did not prevent the effusion from eventually becoming purulent and requiring drainage.

The hope that early use of the drug might prevent the formation of pus was not borne out by the facts. Only one "treated" effusion did not become frankly purulent. The constancy with which pus appeared without any attendant well-marked leucocytosis might have led to the inference that an irritating effect was exerted on the pleuræ. Repeated injections, however, into the pleural cavities of guineapigs and rabbits of the same preparations as were used clinically produced no local reaction whatever.

The continual danger of superadded infection by gram-positive organisms, once drainage had been set up, compelled us to continue with penicillin till no further interference with the wound was necessary. The poor results following rib-resection, where pyogenic secondary infection invariably developed both in controls and "treated," were ascribed to the much freer entry offered to invading bacteria. The large surface of the pleural walls thus exposed provided a ground on which these invaders could readily establish themselves. It is well known that a pneumococcal empyema can heal up seven weeks after rib-resection, and it is a legitimate inference, from the time these organisms take to disappear, that many such empyemata should heal in this time, provided no other infection supervenes. Though the "treated" rib-resection cases were listed as failures, so small a number as 3 would not be sufficient to rule this combination of treatment out of court, but they are a warning to surgeons that, if they carry out rib-resection in the interests of efficient drainage, the risk of secondary infection will be considerably increased. It is suggested that this secondary invasion is responsible for the usual long period after rib-resection before healing takes place.

Superadded infection by gram-negative organisms appeared to have more of a nuisance value than serious consequences. That it can be avoided by a careful dressing technique was demonstrated by a subsequent case treated in a ward otherwise full of battle casualties, every one of whose wounds harboured up to three of the common gram-negative invaders. This patient was treated entirely in this ward, but his cavity, once sterilised, remained so till full healing had taken place.

The sterility on culture of the pus was not an indication for discontinuing drainage. Its unreliability as a criterion was explained partly by the argument that dead and disintegrating matter which has been cast off from inflamed tissues could not be expected to be an exact mirror of the presence of infection in the surrounding living tissues, and by the observation of Wright and others (1918), who described the inhibitory effect of pus on bacterial growth. In spite of this the continued presence of gram-positive cocci in the film rather than in the culture was a most valuable guide to the continuance of infection, and their disappearance to its elimination. (This phenomenon was also noted by Roberts, Tubbs, and Bates 1945.) The time for discontinuance of drainage was therefore based on this finding in combination with disappearance of pus and absence of fluid levels on radiography.

The radiological findings were a source of considerable concern to the clinician. In some cases drainage was prolonged, fruitless explorations were performed after it had been discontinued, and rib-resection and even thoracoplasty considered on the strength of the residual shadows. But every case eventually completely cleared without any further surgical interference. This was the final justification for discontinuing drainage early and allowing the sinus to heal. Screening was of great help in distinguishing between thickened pleura and fluid during and after treatment. A plea is put forward here to regard screening as an essential factor in the treatment of empyemata not only for distinguishing fluid from pleural shadows but also as an aid in correctly siting the tube.

The one death in the whole group of cases fell in the "treated" series. The appearance of this child and the suddenness of its death pointed to the cause being heart-failure, but there was also no hope of treating the infected fluid in the pericardium other than by local instillation. This case therefore falls outside the range of clinical conditions which the treatment here prescribed can cover.

Finally it must be emphasised that careful technique was practised throughout. The finding of the effusion in the initial stages, the correct siting of the drainage tube, and the attention necessary for keeping the tube clear of clots without washouts and of preventing any air from entering into the cavity would not have been possible in unskilled hands. Nevertheless the short period of convalescence before the patient was able to take entire care of himself without needing even a dry dressing justified the intensive and experienced care given to him.

Summary

Techniques for the use of penicillin in the treatment of acute infections of the pleura are described, and results in 20 cases compared with those of a series of 14 controls treated by standard methods.

The result has been to reduce the mean duration of the illness from earliest pneumonic symptoms to complete healing from 15 to 7 weeks, and from drainage to healing from 11·6 to 3·6 weeks.

The technique depends on the use of aspirations and of injections of penicillin as soon as the effusion is recognised, followed, once it becomes purulent, by intercostal drainage alternating with instillation.

The choice of a systemic or local dose depends on whether or not the toxæmic phase is passed and the infection well localised.

The results have been obtained irrespective of the age of the patients or attendant pathological conditions, except exudative pericarditis, but they depend on careful and skilled technique.

We wish to thank Dr. Walter Pagel for his kindness in carrying out biological experiments for us; Dr. J. S. Bray and the laboratory staffs of both hospitals for the bacteriological examinations; the radiological and the nursing staffs for their unremitting help; Mr. R. M. N. Atherstone and Miss Barber for the illustrations; and Dr. M. A. Jennings for advice on the text.

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HUMAN FERTILITY

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IN his book, *The Natural History of Population*, Raymond Pearl discussed the case-records of 199 married couples, collected over a period of 12 years. This sample, which he considered "probably reasonably representative of American urban conditions," consisted of couples who were "not sterile," who had "never made any sort of contraceptive effort during their wedded lives," whose sexual habits "were reasonably constant," and whose "pregnancies and births experienced are correctly recorded." The information about the sexual habits of these people came primarily from the wife but was independently checked in many cases by separate interviews with the husband.

Pearl distinguished between total and net potentially effective coitus frequencies, the latter excluding coitus taking place while the woman is pregnant. He stated: "If only potentially effective copulations be considered there were of these, on the average, 254 for each pregnancy and 301 for each live birth." In a later article (Pearl 1940) the average monthly frequency of coitus of these couples is given as 10·5; so it appears that the women took, on the average, about 24 months to conceive. If his facts are as stated, and if the sample is accepted as representative, his conclusion "The relative sterility of the human organism is truly the marvel rather than fertility" must be acknowledged.

Clinical experience in England, however, does not support the view that women who have conceived have done so only with difficulty. Impressions are, however, notoriously misleading; so a short investigation was planned and initiated to obtain factual evidence concerning the ease with which conception takes place.

METHOD

A questionnaire was prepared to obtain the following details—age and number of conceptions; menstrual habit; age at time of each conception; duration and methods of birth-control (if practised) before conception; number of menstruations before conception *; approximate frequency of coitus at the time pregnancy was desired; whether pregnancy was planned or a "mistake"; any history of previous treatment for sterility; and in some cases the degree of sexual satisfaction experienced during coitus.

Patients attending antenatal, postnatal, and gynæcological clinics of the Radcliffe Infirmary, Oxford, were chosen for convenience. Only those who had conceived were interviewed; sterile married couples were excluded. A separate card was used for each conception. No record was kept of third and subsequent conceptions.

Just over 200 women were questioned. A few were such poor witnesses that a satisfactory record was not obtained; 197 were able and prepared to answer the questions. Some, indeed, because of their difficulties, were glad of the opportunity to discuss the intimate details of their married lives. Each woman was interviewed alone by me.

To get the quick coöperation of the woman questioned, she was told that her help was needed and why; that a few personal questions would be put, which, however, she was under no obligation to answer. Some explanation of the reason for the interview was essential for its

* If the husband was away for weeks at a time, this figure was adjusted accordingly. For example, a woman taking 9 months in all to conceive, but whose husband was on active service, getting home only for 10 days every 3 months, was considered to have conceived within 30 days—i.e., to have had only one menstruation.