reported to have said that he had worked with petrol all his life and it had never hurt him. One charge-hand, another severe case, thought that fifteen years of work with petrol absolved him from the necessity for taking precautions.

Treatment

All that is necessary in the milder cases is removal from exposure, light exercise in the open air, a normal diet with plenty of fluids, and the relief of sleeplessness by adequate doses of a suitable sedative, preferably one of the barbiturates. The treatment of the severe case calls for strict nursing supervision in view of the impulsive suicidal tendencies sometimes displayed, and for adequate fluid intake and sedation.

Glucose, 5% in saline, may be given intravenously up to 3 litres per day. If given as a drip, hexobarbitone may be added. "Somnifaine" and pentobarbitone sodium are other suitable sedatives, and may be given in repeated full doses to obtain rest. A retention enema of 4 to 6 oz. (110–170 g.) of a saturated solution of magnesium sulphate often has a quieting effect when it can be retained. Morphine is contraindicated. Machle (1935) recommends the intravenous administration of from 2 to 4 g. of magnesium sulphate in 2% solution accompanied by doses of pentobarbitone sodium up to 15 gr. (1 g.) daily by mouth. Reference to Case 2 of this series will give some idea of the amount of sedation which may be required in a severe case.

Ample fluids should be given throughout subsequent convalescence to aid the elimination of lead. After a severe exposure many months may elapse before the urinary lead concentration reaches a normal figure.

Summary

The properties of tetra-ethyl lead are briefly recalled.

The opportunities to develop tetra-ethyl lead poisoning in this country are described.

Twenty-five cases of tetra-ethyl lead poisoning of varying degrees of severity occurred during tank-cleaning operations, and six of the cases are described in detail.

The symptoms, diagnosis, and treatment of tetra-ethyl lead poisoning are discussed briefly.

We are indebted to Dr. R. W. Zeitlin for his help in two of these cases, and especially for his care of one of them throughout its course to a happy conclusion; also to Dr. Stanley H. Coleman, Dr. R. E. Hemphill, and Dr. G. Schwizer for their assistance in three other cases. The chemical analytical work upon which these observations are based was carried out in the Courtauld Institute by Mr. E. R. Smith. The blood examinations were performed by Mr. R. L. Harding, and to both of these gentlemen we wish to express our thanks.

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The first number of *Anaesthesia*, the journal of the Association of Anaesthetists of Great Britain and Ireland, has now been published. It opens with a foreword by Sir Alfred Webb-Johnson, P.R.C.S., wishing the journal every success, and noting that the year of celebration of the centenary of the first operation under general anaesthesia in this country is a most opportune time for founding a journal which will make British teaching and records of discovery and achievement available for the medical profession throughout the world. The editor, Dr. C. Langton Hewer, contributes a note giving the reasons for launching *Anaesthesia;* and this is followed by an article on the inception and purpose of the Association of Anaesthetists written by Dr. H. W. Featherstone, its first president, and another, on the centenary of anaesthesia in Great Britain, by Dr. A. D. Marston, who now holds that office. The rest of the issue is taken up with short practical articles, a review, and some abstracts and items of news. *Anaesthesia* is published quarterly from 24, Thayer Street, W.1.

POST-PENICILLIN JAUNDICE

BY

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During recent years increasing numbers of cases have been reported in which infective hepatitis has been conveyed to patients by means of an infected injection. The cases fall naturally into two groups, the first of these being cases in which infected serum has been injected either intravenously or intramuscularly. Beeson (1943), Morgan and Williamson (1943), Steiner (1944), and other authors have reported the occurrence of jaundice after transfusion with whole blood or blood plasma. Similarly, hepatitis has followed administration of convalescent serum in the treatment of mumps and measles; jaundice has also occurred after yellow fever immunization where the vaccine contained human blood serum. Experimentally the disease has been transmitted to human volunteers by injection of blood or serum from patients in the pre-icteric or early icteric stages; this experimental work was summarized by McCallum (1944).

Into the second group fall those cases in which the disease may be conveyed by an infected needle or syringe. Salaman *et al.* (1944) reported a high incidence of jaundice in patients receiving intravenous injections of arsenic for syphilis at the Royal Victoria Hospital, Netley, and showed that the incidence of this condition could be much reduced by careful sterilization of needles and syringes. Sheehan (1944) reported further such cases, and considered that hepatitis following the administration of neoarsphenamine was due to the transmission of a blood-borne virus from one patient to another by unsterile syringes. Droller (1945) described an outbreak of jaundice at a diabetic clinic due to the collection of blood for blood-sugar estimation, and Sheehan (1944) reported cases following the withdrawal of blood for estimation of the erythrocyte sedimentation rate. It is here of interest to recall that Murray (1930) reported a high incidence of jaundice in patients treated with intravenous acriflavine for gonorrhoea; there can be little doubt from his description that the cases were identical with those at present under discussion.

Case Histories (Military General Hospitals)

During the past few months, while working in military general hospitals in India, it was noted with interest that a large number of cases of infective hepatitis admitted to medical wards gave a history of having received a course of penicillin injections within the previous seven months. A total of 124 cases of hepatitis were seen, and 36 of these were found to have had penicillin treatment. Clinically these cases were indistinguishable from those of infective hepatitis, post-arsphenamine jaundice, and homologous-serum jaundice admitted during the same period; hence it is unnecessary to describe the history of each case separately and in detail.

The initial symptoms were loss of appetite, abdominal discomfort, flatulence, nausea, and occasional vomiting, followed four or five days later by the onset of jaundice. On admission to hospital there were generally a slight fever for a few days, a moderate degree of icterus, and a palpable tender liver; the urine contained bile salts and bile pigments, and there was a moderate degree of granulopenia and also a raised icteric index or bilirubinaemia. One or two of these patients were seriously ill for a few days, but the majority of cases were quite mild; with strict bed rest the fever and other symptoms rapidly subsided, the jaundice cleared, and the patient was fit for discharge from hospital at the end of three or four weeks. There were no fatal cases. Table I gives a more detailed analysis of the cases seen.

TABLE I.—*Analysis of Cases of Infective Hepatitis*

Total number of cases of infective hepatitis		124
Number of these cases with a history of penicillin injections within the previous 7 months		36
Cases of gonorrhoea treated with penicillin*	9	
Cases of syphilis treated with penicillin*	15	
Cases of gunshot wounds treated with penicillin	2	
Dermatological cases treated with penicillin	1	
Cases of syphilis treated with penicillin but had had injections of arsenic and bismuth	5	
Cases of gunshot wounds treated with penicillin but had received blood or plasma transfusions	5	

* One case is included in both these groups, as the patient had gonorrhoea and later syphilis within the relevant period; both these diseases were treated with penicillin.

If the last two groups in Table I are excluded as possible cases of post-arsphenamine and homologous-serum jaundice there are left 26 cases (or 21% of the total number seen) in which the jaundice might be ascribed to penicillin treatment. Further details of these 26 cases are given in Table II.

TABLE II.—*Clinical Details of Cases of Post-penicillin Jaundice*

Case No.	Age	Disease	Dose of Penicillin (units)	Date Drug was Started	Date Drug was Stopped	Date of Onset of Hepatitis	Interval in Days	
							Min.	Max.
1	23	Syphilis	2,000,000	16/2/45	28/2/45	22/4/45	53	65
2	22	Gonorrhoea	100,000	6/2/45	6/2/45	17/5/45	100	100
3	30	Syphilis	2,000,000	17/3/45	29/3/45	13/6/45	76	88
4	28	,,	2,000,000	19/2/45	4/3/45	27/5/45	84	97
5	34	Gunshot wnd.	1,333,300	27/3/45	7/4/45	19/6/45	73	84
6	20	Syphilis	2,000,000	28/3/45	9/4/45	25/6/45	77	89
7	34	,,	2,000,000	19/4/45	1/5/45	29/6/45	59	71
8	22	,,	2.400,000	10/2/45	17/2/45	29/6/45	132	139
9	23	,,	2.000,000	14/4/45	26/4/45	4/7/45	69	81
10	20	Gunshot wnd.	1,000,000	20/2/45	2/3/45	13/7/45	133	143
11	22	Gonorrhoea	100,000	14/12/44	15/12/44	15/7/45	212	213
12	23	Gonorrhoea, syphilis	100,000 2,400,000	3/5/45 23/6/45	4/5/45 30/6/45	3/8/45	34	92
13	21	Furunculosis	480,000	2/5/45	6/5/45	13/7/45	68	72
14	24	Gonorrhoea	100,000	1/5/45	2/5/45	24/7/45	83	84
15	23	,,	100,000	1/5/45	2/5/45	10/8/45	100	101
16	35	Syphilis	2,400,000	22/3/45	29/3/45	16/7/45	109	116
17	26	Gonorrhoea	100,000	11/3/45	12/3/45	25/5/45	74	75
18	23	Syphilis	2,000,000	23/4/45	5/5/45	16/6/45	42	54
19	27	,,	2,400,000	29/3/45	5/4/45	23/6/45	79	86
20	27	,,	2.400,000	5/3/45	14/3/45	2/8/45	141	150
21	24	,,	2,400,000	12/4/45	20/4/45	12/7/45	83	91
22	25	Gonorrhoea	100,000	15/1/45	16/1/45	19/6/45	154	155
23	31	,,	100.000	4/5/45	4/5/45	16/8/45	104	104
24	32	,,	140,000	5/4/45	7/4/45	18/8/45	133	135
25	26	Syphilis	2,000,000	27/5/45	8/6/45	30/8/45	83	95
26	28	,,	2,000,000	28/5/45	9/6/45	31/8/45	83	95

In each of the above cases the penicillin was given by intramuscular injection at 3-hourly intervals. Gonorrhoea was usually treated with 5 injections of 20,000 units and syphilis with 100 injections of 20,000 units or 60 injections of 40,000 units.

Comment on the Cases

On questioning an unselected series of 100 patients in the medical wards of the hospital it was found that only 4 of these had been treated with penicillin in the previous 7 months, hence there can be no doubt that the high percentage of jaundiced patients that had been treated with this drug is of statistical significance.

So far as is at present known, penicillin has no toxic effects when used in therapeutic doses. Local pain at the site of injection, venous thrombosis (when the drug is administered intravenously), fever, and urticarial rashes are all occasionally met with, but are considered to be due to impurities. One patient of a further series, reported below, received a total of 23,220,000 units within 48 days without any toxic effects being produced.

Clinically these cases were indistinguishable from other forms of jaundice known to be transmissible—infective hepatitis and post-arsphenamine jaundice. If in fact the disease was conveyed by the penicillin injections the incubation period is closely comparable with that known in the above two types of jaundice. In the present series the incubation period is 34 to 213 days; in post-arsphenamine jaundice the incubation period is about 100 days. Cameron (1943), in his report on the experimental transmission of infective hepatitis to human volunteers by injection of blood or serum from jaundiced patients, stated that the incubation period varied from 30 days to 6 months. The unusually long latent period of 212 to 213 days in Case 11 suggests that the association of penicillin treatment with jaundice may have been coincidental. The most probable explanation is that post-penicillin and post-arsphenamine jaundice are identical and due to an infective agent conveyed from patient to patient by the injections. This would explain the relative frequency of jaundice after the treatment of syphilis (15 cases) and gonorrhoea (9 cases). In a V.D. treatment centre in this area 135 cases of syphilis and 419 cases of gonorrhoea were treated in a period of 8 months. The higher incidence of jaundice in syphilitics may be explained by the much larger number of injections (either 60 or 100) given and so the much greater possibility of conveying the infection to the patient.

Cases of Jaundice occurring in a Penicillin Research Unit

This unit, which was attached to an Indian Base General Hospital, was investigating the effect of penicillin treatment on chronic bone infections due to war wounds. The cases were treated in a ward of 80 beds, in which also cases of the same type were being treated by the general surgeons. Many of the cases had had blood or plasma transfusions and injections of penicillin before admission.

During the period of the outbreak 170 cases were treated in the ward, and 66 of these were given penicillin injections; 10 cases of jaundice occurred, 9 of them in patients who had had penicillin since admission. The other—the first case of the series—had had penicillin at another medical unit two months previously. Table III gives further details of these cases.

TABLE III.—*Clinical Details of Cases of Jaundice at a Penicillin Research Unit*

Case No.	Date of Wound	Penicillin Given Before Admission		Date Admitted to Unit	Penicillin Given at Research Unit		Date of Onset of Jaundice
		Date Started	Dose (units)		Date Started	Dose (units)	
1	18/11/44	21/11/44	950,000	26/1/45	9/2/45	23,220,000	26/1/45
2	3/8/44	—	0	14/8/44	6/9/44	840,000	29/1/45
					22/9/44	1,200,000	
					2/1/45	3,220,000	
3	16/3/44	—		3/5/44	4/1/45	2,240,000	24/3/45
					17/4/45	1,600,000	
4	29/5/44	—	0	25/11/44	2/1/45	2,240,000	8/4/45
5	15/1/45	16/1/45	300,000	26/1/45	1/2/45	2,240,000	24/4/45
					6/3/45	4,000,000	
6	31/1/45	—	0	17/3/45	23/3/45	800,000	3/5/45
7	11/10/44	18/10/44	1,400,000	5/1/45	16/1/45	2,240,000	16/5/45
					24/3/45	1,440,000	
8	16/1/45	16/1/45	300,000	26/1/45	1/2/45	2,240,000	21/6/45
					2/3/45	2,240,000	
9	15/5/44	—	0	25/10/44	21/2/45	1,880,000	24/6/45
10	14/5/45	—	0	17/6/45	3/7/45	320,000	2/9/45

With the exception of Case 1, penicillin was given to the above patients in doses of 20,000 units 3-hourly by intramuscular injection while at the Research Unit.

In this small series of cases there was one fatality (Case 6). The patient was a male of 18 years who sustained machine-gun bullet wounds of both legs and a compound fracture of the right femur. On May 3, 1945, when convalescent from his wounds, he developed infective hepatitis and malaria (B.T.). The latter condition responded to mepacrine treatment, but the hepatitis progressed, and he died on May 17. At post-mortem examination extensive liver necrosis was found.

Discussion of Research Unit Cases

In a closed community of this type the possibility of spread by droplet or intestinal infection must always be considered; however, in view of the fact that jaundice was confined to one ward only, and in that ward to the penicillin-treated cases, spread by syringe infection seems a more likely explanation. In this ward great care was taken over the sterilization of needles and syringes. The dose of 20,000 units of penicillin was made up to a volume of 2 ml., a freshly sterilized needle was used to withdraw this from the ampoule, and a second needle to inject the drug into the patient. In some cases a freshly sterilized syringe was employed for each patient, but at times the same syringe was in use for several patients in succession. Needles and syringes were sterilized by boiling for 20 minutes; the needles were handled only with forceps.

It is difficult to attempt to trace the spread of the infection from patient to patient: first, because an unknown percentage of the cases of hepatitis remain non-icteric and undiagnosed; secondly, because the period during which the patient is infectious is still not known. Lisney (1944) states that the patient is infectious for at least one week before the appearance of the jaundice, while Sheehan claims that the patient becomes infectious about one month after the onset of the incubation period. McCallum and Bauer (1944) have succeeded in conveying homologous-serum jaundice to volunteers by injection of serum withdrawn on the seventh day of the jaundice.

If Case 2 was infected by injections in September, 1944, he could have transmitted the disease to Cases 3, 4, and 7 by means of the course of injections starting on Jan. 2; and Case 7 could have passed the disease on to Case 6 by means of the course starting on March 24. Again, if the patient still remains infectious as long as 14 days after the onset of jaundice, then Case 1 may have transmitted the condition to Cases 5 and 8.

Syringe Contamination during Intramuscular Injection

While faulty technique of sterilization or injection might lead to syringe contamination it was felt that this could not be the usual explanation of these cases of jaundice and that the traditional method of giving a series of injections from one syringe (while using a fresh needle for each patient) might well be at fault. Further investigation confirmed this view and demonstrated the frequent presence of blood in the syringe after a single intramuscular injection had been given.

Red Blood Cells in the Syringe after Intramuscular Injection

As it was impossible to detect minute quantities of blood plasma with the apparatus available it was decided to concentrate on detecting red blood cells in the syringe contents after an intramuscular injection. The following technique was evolved.

The needle and syringe were filled with sterile normal saline (0.85% sodium chloride), the needle (with the syringe attached) was inserted into the quadriceps extensor cruris, and 1 ml. of saline was injected. The needle, with the syringe still attached, was then immediately withdrawn, the needle was removed, and succeeding drops of saline from the tip of the syringe were examined microscopically for red blood cells; these were counted in a Neubauer counting chamber.

The syringes used were of the standard Army pattern, 2 ml., 5 ml., and 10 ml. in size; the needles were the usual issue of sizes 19, 21, and 23 (Birmingham English standard wire gauge), with a length of 50 mm., 38 mm., and 25 mm. respectively. The apparatus was freshly autoclaved before each injection. The results obtained are summarized in Table IV.

TABLE IV.—*Red Blood Cells found in the Syringe After an Intramuscular Injection*

(A) Injections Given Into a Muscle in a State of Active Contraction

Syringe	Needle	Volume Injected	No. of Red Cells in 0·9 c.mm. of Saline			
			Drop 1	Drop 2	Drop 3	Drop 4
ml.	S.W.G.	ml.				
2	23	1	3	0		
10	23	1	163	6	0	
2	23	1	2	0		
10	23	1	80	0		
2	23	1	57	0		
2	23	1	0			
5	23	1	0			
2	23	1	9	0		
5	23	1	0			
2	23	1	0			
2	23	1	0			
2	23	1	0			
5	23	1	0			
5	23	1	4	0		
2	21	1	0			
2	21	1	0			
2	21	1	72	27	0	
5	21	1	2	0		
5	21	1	0			
2	21	1	8	1	0	
10	21	1	4	0		
2	21	1	0			
10	21	1	0			
2	19	1	204	4	2	0
10	19	1	51	33	3	0
2	19	1	3	2	0	
10	19	1	243	19	13	0

(B) Injections Given Into a Relaxed Muscle

ml.	S.W.G.	ml.				
2	23	1	0			
2	23	1	0			
10	23	1	0			
10	23	1	0			
2	21	1	0			
2	21	1	1	0		
2	21	1	0			
2	21	1	0			
2	21	1	0			
2	21	1	0			
10	21	1	2	0		
10	21	1	0			

Thus contamination of the syringe with red blood cells had occurred in 17 out of a total of 39 injections. This statement, however, needs further comment. It will be noted from Table IV that the red cell count rapidly diminished with each succeeding drop; this suggests that the syringe contents generally are not contaminated, but that the contamination is confined to the small drop of fluid on or in the nozzle of the syringe when the needle is removed. This fact was further confirmed by the following experiment. A series of five intramuscular injections of 1 ml. was given from the same 10-ml. syringe; drops of saline were examined microscopically until no further red cells were found, and then the remaining fluid in the syringe was ejected into a centrifuge tube and spun for 10 minutes. On examining the fluid from the bottom of the centrifuge tube only one or two red cells could be found. From the above results it is apparent that the frequency and severity of syringe contamination vary according to whether the muscle iniected is relaxed or is in a state of active contraction. With the muscle contracted, contamination occurred in 15 out of a total of 27 injections and up to 243 red cells in 0.9 c.mm. of saline were counted; with the muscle relaxed, however, contamination occurred in only 2 out of a total of 12 injections and a maximum of 2 red cells in 0.9 c.mm. were found.

Experiments have shown three possible mechanisms which, either separately or together, might account for this contamination. These are: (*a*) back pressure, forcing fluid from the muscle into the needle; (*b*) spread of blood from the tip of the needle towards the syringe; and (*c*) suction when removing the needle from the syringe, aspirating the needle contents back on to the tip of the latter.

Back Pressure from the Muscle

For some time it has been recognized by the dental profession that, when injecting a local analgesic under pressure into the fibrous tissue of the gum, fluid is forced back and contaminates the syringe. Hence it is customary for dentists to use a clean syringe for each different part of the gum if any evidence of infection is present. Again, when giving an intramuscular injection with a small syringe it is not uncommon to note that the plunger returns for a short distance when the pressure is released at the end of the injection. To demonstrate this more accurately a series of 12 intramuscular injections of 1 ml. of normal saline were given into the contracted quadriceps by means of a 1-ml. vaccine syringe. In two instances fluid was noted to return, to approximately the volume of 0.02 and 0.04 ml.

Further experiments were carried out in which saline was injected intramuscularly, and immediately the injection was completed the needle was switched (by means of a two-way tap) to a manometer, which consisted of a 1-ml. micropipette graduated in hundredths of a millilitre. The results obtained are detailed in Table V.

TABLE V.—*Return of Fluid from the Muscle After Injection*

Volume of Fluid Injected (ml.)	Muscle Tone	Volume of Fluid Returned (ml.)
0·5	Relaxed	0·0025
1·0	,,	0
2·0	,,	0·005
3·0	,,	0·100
0·5	Contracted	0·045
1·0	,,	0·010
2·0	,,	0
0·5	,,	0·010
1·0	,,	0
2·0	,,	0·035

Thus varying amounts of saline up to a maximum of 0.1 ml. were returned from the muscle into the manometer. These latter results, however, are open to criticism. In the first place, a certain rise of fluid level in a narrow-bore tube can be caused by the surface tension of the fluid. Further experiments suggest that this may partly explain these results, but it is my opinion that this is not the whole explanation and that the return of fluid is in part due to the elasticity of the muscle. Secondly, the conditions of the experiment are not comparable with those existing when a routine injection is given and when returning fluid displaces the heavy plunger of a syringe; it seems possible (although it is not proved) that returning fluid can displace fluid through leaky joints in the syringe without moving the plunger at all.

Spread of Blood Along the Needle Towards the Syringe

If the tip of the needle is contaminated with blood the red cells gradually spread along the needle towards the syringe.

To demonstrate this the following technique was used. An all-glass 2-ml. syringe with a No. 23 needle attached was filled with normal saline and a tiny drop of citrated blood (as used for estimation of sedimentation rate by the Westergren method) was placed on the tip of the needle by means of a Pasteur pipette. After an interval varying from 15 to 60 seconds the needle was cut off at the socket with wire-cutters, the socket removed from the syringe, and the drop of saline on the tip of the syringe examined for red cells. It was found that contamination could occur in 45 seconds, as the results shown in Table VI demonstrate.

TABLE VI.—*Spread of Red Cells Along the Needle Towards the Syringe*

Time Interval between Application of Red Cells and Cutting the Needle	No. of Red Cells in 0·9 c.mm. of Saline in Drop at Tip of Syringe				
	Expt. 1	Expt. 2	Expt. 3	Expt. 4	Expt. 5
15 secs.	0	0	0	0	0
30 ,,	0	0	0	0	0
45 ,,	0	4,608	396	0	0
60 ,,	780	0	0	13,392	13,392

Aspiration of Contents of Needle when it is Removed from the Syringe

That this actually occurs can be very simply demonstrated. A syringe with needle attached is filled with fluid and the plunger pressed until a small drop of fluid appears at the tip of the needle; if the needle is then removed from the syringe the drop is immediately sucked back.

Gross contamination of the syringe by this mechanism was demonstrated with a similar method. The syringe, with the needle attached, was filled with normal saline and a tiny drop of citrated blood was placed on the needle-tip; the needle was then removed from the syringe and the drop of saline at the tip of the syringe was examined for red cells. Contamination resulted, as can be seen in Table VII.

TABLE VII.—*Aspiration of Needle Contents on Removal from Syringe*

Size of Needle	No. of Red Cells in 0.9 c.mm. of Saline in Drop at Tip of Syringe		
	Experiment 1	Experiment 2	Experiment 3
23	105	Too numerous to count	Too numerous to count
21	Too numerous to count	14,544	,, ,,
19	70,560	26,784	,, ,,

Further experiments, which it is unnecessary to detail here, have shown that the amount of fluid which can be aspirated by this means may be as large as 0.1 ml.; this is more than the internal volume of the needles used. Hence it is probable that when the needle is removed from the syringe the whole of the contents of the needle (but not of the socket) are aspirated and replaced by air.

Discussion on Syringe Contamination

From the above experiments it is clear that in a high proportion of cases a syringe is contaminated after a single intramuscular injection of 1 ml. has been given. The limited number of investigations carried out suggests that contamination occurs as follows. A small amount of fluid is forced back into the needle after the injection, or traces of blood are left on the tip of the needle when it is withdrawn; this blood tends to spread slowly along the needle, and on removing the latter from the syringe the needle contents are aspirated, leaving a contaminated drop of fluid on the tip of the syringe. This drop contaminates the next injection despite the changing of the needle. It seems possible that in exceptional circumstances (and particularly when a large quantity is injected) fluid is actually forced from the muscle into the syringe and directly contaminates the syringe contents.

Summary

A series of cases of jaundice following penicillin treatment is reported. It is considered that this condition is transmitted from patient to patient by means of contaminated syringes.

Experiments are described which show that a single intramuscular injection of 1 ml. of fluid may lead to contamination of the syringe used. The mechanism by which this contamination occurs is discussed.

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PYOGENIC OSTEOMYELITIS OF THE SPINE

BY

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Although pyogenic osteomyelitis of the spine is generally considered to be a rare and fatal disease, a perusal of the literature and a more ready appreciation of the possibility of the condition lead to the conclusion that it is considerably more common than was originally thought and that it is by no means so fatal as has been considered. Wilensky (1934) and Kulowski (1936) in the United States have described the condition well, and Turner (1938) in this country has added to our knowledge. It is agreed that osteomyelitis of the spine, forming part of a generalized bacteriaemia, has been almost invariably fatal, and Butler *et al.* report a mortality of 100% in 13 cases, all occurring in children and young adults. It may be that penicillin will brighten this gloomy picture.

These cases are often so acute and fulminating that an antemortem diagnosis is not made owing to the intense toxaemia of the patients; the more hopeful variety of the disease is that where the pathology is limited to one or other region of the spine, and in these cases the mortality rate is somewhere in the region of 25%. There is reason to suppose that cases labelled tuberculosis of the spine, which do so well with an early firm bony fusion, are in reality cases of pyogenic osteomyelitis, as will be discussed later, and when these cases are recognized it may be that the mortality is even lower.

The disease is approximately three times more common in males than in females, and the age of onset is predominantly the third decade—that is, after the vertebrae are fully formed—thereby differentiating it from osteomyelitis occurring in long bones. This age incidence is no doubt due partly to the fact that there is no true epiphysial growth in the vertebral bodies, and partly to the presence of a cellular bone marrow with a sluggish blood flow, thereby encouraging embolism and thrombosis in pyaemic states. Such a condition of bone and blood flow is normally present in the metaphysial areas of long bones, thus accounting for the more usual incidence of osteomyelitis in these bones in adolescence.

Aetiology and Pathology

The influence of trauma as an aetiological factor is doubtful, and in Kulowski's series of 102 cases there was a history of trauma in 30%. In the present series Case 4 appears to date from a fall, and Case 3 is of interest as occurring after a lumbar puncture, whether or not that was a factor; but in the remainder there does not appear to have been any injury.

The lumbar region is most frequently involved, and the bodies of the vertebrae are generally affected, usually as a metastatic phenomenon, the primary focus being recognizable in about half the cases as a topical infection such as a boil, whitlow, tooth infection, septic wound, or another focus of osteomyelitis; and the causative organism, if it can be obtained either directly or by blood culture or from the primary focus, is a *Staph. aureus*, less commonly *albus*, or rarely a streptococcus. Direct infection can of course occur.

Pyogenic infection in the early stages gives rise to an ulcerating lesion showing a liability to spread to adjacent segments.