All but 2 were tested for at least 6 weeks. The results are summarized in Fig. 1. It can be seen that altogether 5 children developed bilirubinuria during the course of the investigation, and in 4 cases tests were positive on more than one occasion. As soon as a suspicious or positive result occurred the child was isolated and kept in bed until 3 successive negative tests had been obtained. A detailed summary of findings in all positive cases is given in the accompanying Table. Unfortunately, in only two instances was

Summary of Findings in those Children in Nursery A who showed Positive Hunter's Tests during the Investigation

Name	Age	Date of First Positive Hunter's Test	Serum Bilirubin		Remarks
			Date	Mg./100 c.cm.	
A.W.	4½	March 19	—	—	No symptoms March 21: Liver not felt; no abdominal tenderness
K.R.	4	„ 21	March 21	0.8 (Direct van den Bergh reaction: positive)	March 20: lethargic; anorexia March 21: Vomited; liver not felt; slight tenderness R. hypochondrium
B.F.	4	„ 26	„ 28	0.4	March 28: nausea and vomiting. T. 100°. Liver not felt; no abdominal tenderness
S.L.	2½	April 11	—	—	No symptoms April 12: T. 100° April 15: Urine "dark"; liver definitely enlarged and slightly tender
J.S.	5	„ 23	—	—	No symptoms April 25: Liver palpable but not enlarged; no abdominal tenderness

it possible to collect blood for the estimation of serum bilirubin. It must be pointed out that the degree of bilirubinuria was relatively slight, since Hunter's test is a great deal more sensitive than most other urine tests for bilirubin, a +++ result corresponding roughly to a just-positive iodine ring test. None of the children ever developed jaundice, but K.R. would probably have been recognized as a "subicteric case," since he was passing very obviously dark urine and had a well-defined clinical attack.

The only child of those being investigated who developed any symptoms without bilirubinuria was P.B., who vomited once on the night of March 31; her temperature was normal and she was perfectly well the next day. Six other children, not in the series, vomited each on one occasion during the period of the investigation; Hunter's tests, performed the following day, were all negative, and with one exception—a boy who developed a temperature of 101.4° and was not well for about a week—recovery was almost immediate. Vomiting is, of course, not infrequently encountered in children of this age, and it is difficult to ascribe much significance to this symptom alone.

It is thus possible to say that suggestive evidence of liver damage and therefore of infection with the agent of infective hepatitis (known to be present in the community) was obtained in 3 cases in the absence of significant symptoms. The most striking cases were S.L. and A.W., both of whom gave repeated unequivocal positive tests over a period of several days without ever developing symptoms. It is unlikely that either would in the ordinary way have been suspected as possible cases, although S.L. was noticed to have passed dark urine on one occasion 4 days after the first positive test; her temperature would not have been taken had she not been under suspicion because of her bilirubinuria, since she appeared perfectly well. In one other case (B.F.) considerable bilirubinuria occurred two days before the onset of symptoms, and in K.R. a suspicious result was obtained one day before the onset.

The sequence of cases in the epidemic is shown in Fig. 2. If all the children who developed bilirubinuria are included as possible cases, it is likely that A.W., K.R., and B.F. were infected at the same time as the first-reported child victim (P.H.)—presumably by one of the two staff cases that occurred in February—and that S.L. and J.S. were secondarily infected from them. The time of occurrence of the symptomless "cases" is consistent with the known incubation period of 20 to 40 days.

No further cases of jaundice have occurred in this nursery up to the beginning of October (5 months after the end of the investigation).

Controls

It was considered advisable to investigate under identical conditions similar communities who had not been exposed to any source of infection for several months. Thirty-two children in two other residential nurseries where there had been no record of jaundice among either staff or children for at least 12 months were therefore tested approximately thrice weekly over periods up to 4 weeks. In 4 isolated cases in one of these nurseries suspicious traces of bilirubin were found, although, so far as was known, all the children were well; but there was no positive result out of a total of 302 tests.

Discussion

It must be admitted that these findings have been obtained in very young children, and at the best remain only suggestive. It is possible that efforts to obtain similar results among an adult community would not be successful. It might also be argued that the children were too young to be capable of complaining of slight subjective symptoms which would certainly be commented upon by adults. But the fact remains that definite bilirubinuria occurred among apparently healthy members of a community exposed to the risk of infection, and such bilirubinuria was not present to any significant extent in similar communities not so exposed. It therefore appears possible that infection with the virus of infective hepatitis may be unrecognized even when special efforts to detect cases are made under close medical supervision.

Summary

Suggestive evidence of symptomless attacks of infective hepatitis among a community of young children exposed to risk of infection has been obtained by the repeated use of Hunter's test for bilirubinuria.

My special thanks are due to Dr. G. Hamilton Hogben, medical officer of health for the borough of Tottenham, and to Miss Moody, matron of Tottenham Residential Nursery, Bengoe, Hertford, without whose willing and efficient co-operation this investigation would not have been possible; also to the matrons and staffs of the nurseries at Abberley House, Shelford, and Kensal House, West Wrating, who most generously helped in collecting control specimens from children under their care.

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AMPUTATIONS, RE-AMPUTATIONS, AND PENICILLIN

BY

E. N. CALLUM, F.R.C.S.Ed.

Senior Surgeon and Deputy Medical Superintendent, St. Helier County Hospital, Carshalton; Late Senior Surgeon, Ministry of Pensions Hospital, Chapel Allerton, Leeds

This communication is based on some 102 amputations and re-amputations, 90 of which were performed during a 6-months period at the Ministry of Pensions Hospital, Chapel Allerton, Leeds. There were 19 primary amputations and 83 re-amputations; amputations of digits and trimming operations on soft tissues are not included.

Twelve cases operated on previously to the 6-months period were selected as cases which would have been suitable for post-operative penicillin had it been available. The majority of the 83 re-amputations were performed on patients whose original amputations had been carried out under active-service conditions, where the primary consideration was to save life. All the re-amputations were necessary for limb-fitting purposes. Some of these, however, had undergone primary amputations in ideal hospital conditions, only to be subjected to re-amputation because the original stumps were unsuitable for the fitting of artificial limbs. The reason for this is probably the retention in most textbooks of operative surgery of descriptions of classical amputations which should be revered for their antiquity rather than practised by surgeons. An invaluable book on the

subject is *Amputations and Artificial Limbs*, by Kelhan and Perkins (Oxford University Press). The operation is not merely the removal of a diseased or mutilated limb, but the first step towards supplying the patient with an artificial limb. As was pointed out by Mr. St. Clair Strange at a meeting of the British Orthopaedic Association (reported in the *Journal*, Jan. 13, 1945, p. 56), the amputation stump is a new and normal organ, upon the perfection of which depend the subsequent health and happiness of the patient.

Careful operative technique, with particular attention to haemostasis, will amply repay the patience and trouble expended. In many cases sepsis in an amputation stump follows haematoma formation, and this can be avoided only by careful technique. Except in extreme urgency, to aim at speed in amputations is folly, and is a relic of the pre-anaesthetic era of surgery. The important points are: (i) snugly fitting anterior and posterior flaps; (ii) avoidance of lateral flaps; (iii) meticulous attention to haemostasis; (iv) drainage for a limited time, usually 24 to 48 hours; (v) careful post-operative bandaging and early stump movements.

It has been stated by Mr. Strange (*loc. cit.*), quite correctly, that a re-amputation should be approached in the same spirit as, for example, a bone graft, and that adequate time must be allowed after the healing of the original wound sepsis before embarking on the operation. There is, however, an additional important factor with which this paper is concerned—namely, the effect on the patient of prolonged hospital treatment and lack of a limb. Many septic stumps take a very considerable time to heal, only to be re-amputated before an artificial limb can be fitted. The effect of all this is bad for the morale of the patient, besides being a serious economic handicap to himself and the State—delaying as it does his reinstatement as a useful member of the community.

Results with Post-operative Penicillin

For these reasons we have, in certain cases, been performing re-amputations with the help of post-operative penicillin before the original wound had healed, or when it had only just healed. In many of these cases the wounds were of the type that "looked as if they would never heal"—to quote a nursing sister. In none of these cases was operation undertaken in the presence of obviously active inflammation or profuse discharge, and in all cases but one (in which healing was considerably delayed) the organisms present in the discharge were predominantly penicillin-sensitive. In other cases post-operative penicillin has been used on account of a past history of severe infection or of the presence of bone disease, and in these cases operation has been undertaken earlier than would otherwise have been feasible.

The first series (Series A) comprises 34 cases treated with post-operative penicillin, locally in all cases, and in a few instances by the systemic route as well. The local penicillin was administered by means of small-bore rubber tubing with lateral holes, stitched across the wound and coming out at each corner, the flaps being accurately and firmly sutured together. The dosage in most cases was 5,000 units twice daily for 5 days in the case of local therapy, while the systemic course was 15,000 units every 3 hours, also for 5 days, by intramuscular injection. The remaining 68 cases were in the nature of controls, and did not receive penicillin. 47 of these cases (Series B) were "clean," and could, on general surgical principles, be considered safe for operation. The remaining 21 cases (Series C) were more doubtful, and were of the type which would probably have benefited from post-operative penicillin if available.

The results are shown in Tables I to IV. To give an indication of the progress of cases the average periods have been calculated (in weeks approximately) between the time of wounding and the time when first measurements were taken for artificial limbs, and again between the time of the amputation or re-amputation under consideration and first limb-fitting action. This latter time-period gives a very fair indication of the success of the operations under consideration in the three series.

In Table I it will be seen that in Series A these average times are 35½ and 10 weeks respectively. In Series B they are 29½ and 7 weeks; while in Series C they are 35 and 21 weeks. In this

last series it should be noted that 8 cases are still unhealed, so that the average times of healing would really be considerably higher if these had not been omitted from the calculation. There were no such failures in the penicillin series (A) or in the "clean" series (B); while the failures in Series C comprise 38.5% of that series, which contained cases very similar to those

TABLE I.—Analysis of All Cases

Series	No. of Cases	Average Time Wounding to Limb-fitting	Average Time Operation to Limb-fitting	Delayed Healing (No. and %)	Unhealed (No. and %)
Series A	34	35½ weeks	10 weeks	3 (8.8%)	Nil
Series B	47	29½ "	7 "	0	0
Series C:					
(a) Relative success	13	35 "	21 "	11 (84.6%)	8 (38.5%)
(b) Still unhealed (a and b)	8				
Series B and C combined (unhealed cases excluded)	21				
	60	31 "	10 "	11 (18.3%)	0
Series A, B, and C (unhealed cases excluded)	94	33 "	10 "	14 (14%)	0
Unhealed cases	8				8 (8% of all cases)

Of 90 cases operated on at this hospital during 6 months all have been measured for artificial limbs. Six of the 8 cases still unhealed and 1 of the cases of delayed healing were transferred to this hospital from elsewhere after operation.

in Series A. In this paper an amputation is considered to be a failure if the stump remains unhealed for a long period or if re-amputation has to be performed before limb-fitting is possible.

Table II gives an analysis of cases in Series A, with types of case operated on and some other details. Where more than

TABLE II.—Analysis of Series A (Cases receiving Post-operative Penicillin)

Type of Case	No. of Cases	Details	Average Time Operation to Limb-fitting
Open wounds:			
Successful	16	Penicillin-sensitivity positive in all cases; 3 cases with protrusion of bone	9 weeks
Delayed healing	2	Both below knee; one developed haematoma, one became septic	20 "
Failures	0		
Bone involved:			
Successful	5	One case with protrusion of bone, 4 with osteitis or osteomyelitis	11 "
Failures	0		
Prophylactic penicillin:			
Successful	9	Past history of severe infection	9½ "
Failures	0		
Recently healed stumps:			
Successful	1	Past history of infection	7 "
Delayed healing	1	Above-knee; developed eczema of stump after healing	18½ "
Failures	0		
All types:			
Successful	31		9½ "
Delayed healing	3		16½ "
All cases included	34		10 "
Failures	0		

Percentage of delayed healing, 8.8 (3 out of 34). Best average results were when the penicillin-sensitivity tests were positive.

three months had elapsed between operation and limb-fitting the cases were considered as instances of delayed healing. It may be noted that only 3 such cases occurred out of 34—that is, 8.8%.

Table III provides details of cases in Series C, for comparison with Table II. It is obvious that the results in Series A were very much better than those in Series C, although both series contained similar types of case. Even with the 8 failures left out of account, the average time between operation and limb-fitting was 21 weeks in Series C, as compared with 10 weeks in Series A. It is not too much to claim that the difference in these results is due to the use of post-operative penicillin.

In considering cases of delayed healing in Series A and C it is of interest to note that in at least three instances trouble started with haematoma formation, and in one case the penicillin-sensitivity test was negative.

TABLE III.—*Analysis of Series C (Infected, Non-penicillin)*

Type of Case	No. of Cases	Average Time Wounding to Limb-fitting	Average Time Operation to Limb-fitting
Open wounds still present at operation	Healed .. 5 Unhealed .. 2	41 weeks	20½ weeks
Infected cases*	Healed .. 5 Unhealed .. 6	32 "	21 "
Other factors present†	Healed .. 3 Unhealed .. 0	35 "	21 "
All cases ..	Healed .. 13 Unhealed .. 8	35 "	21 "

* Those with a history of severe infection of the wound.

† One case had a Charcot ankle, one had foreign bodies in the stump, and the third had had an ulcerated leg for years before amputation was undertaken.

Table IV gives details of the 90 cases operated on during a 6-months period, with comparisons between cases receiving

TABLE IV.—*Comparison of Results at Various Amputation Sites (in 90 Cases during 6-months Period)*

Site of Amputation or Re-amputation	Penicillin Series		Control Series		All Cases Combined	
	No. of Cases	Average Time Operation to Limb-fitting	No. of Cases	Average Time Operation to Limb-fitting	No. of Cases	Average Time Operation to Limb-fitting
Above elbow	2	10½ weeks	6	9 weeks	8	9½ weeks
Below elbow ..	2	11 "	10	5½ "	12	6½ "
Above knee ..	19	9 "	11	7½ "	30	8½ "
Below knee ..	11	12 "	29	12 "	40	12 "

and those not receiving post-operative penicillin. The results are given for the various amputation sites. It should be noted that the most difficult site to obtain a good result is below the knee, all but 2 of the 12 cases of delayed healing being below-knee amputations.

Conclusions

The best indications of the success of an amputation or re-amputation are: first, the shortness of time between operation and readiness of the stump for limb-fitting; secondly, the subsequent behaviour of the stump under the strain of wearing an artificial limb. Time alone can show the latter, but the former can be worked out quite easily and gives a reasonable index of the degree of success. It may be added that a rapidly healing stump is usually sounder than a slowly healing one.

Broadly speaking, these series give us the results in 3 types of case. First, potentially or actually infected cases receiving post-operative penicillin; secondly, uninfected cases not receiving penicillin; and, thirdly, potentially or actually infected cases not receiving post-operative penicillin. It is evident that in the uninfected cases the results were best, but they were only slightly better than in the infected cases receiving post-operative penicillin; the relevant average times of healing were 7 and 10 weeks respectively. It should be remembered that many of these infected cases had been grossly infected, and could not have undergone re-amputation for weeks or months later had it not been possible to administer post-operative penicillin; yet there were no failures in this series and only 3 cases of delayed healing. In the third series, even with 8 failures not included, it is found that the average healing-time was 21 weeks—more than twice the period in similar cases which had received penicillin after operation.

From these results it can be claimed that the use of penicillin not only shortens the time between operation and limb-fitting, but makes it possible to operate on doubtful cases considerably earlier than would otherwise be feasible. Convalescence is shortened and a far better prospect of success is assured.

Summary

A report is given of 102 amputations and re-amputations. Of these 55 were infected or potentially so at the time of operation; 34 of them received post-operative penicillin and 21 did not. The results show that, in selected cases, it is possible to operate on infected cases much earlier with than without penicillin, and with good prospects of success. In this way convalescence can be considerably shortened, and the patient can start earning his living earlier.

It is pointed out that there were no failures in the penicillin series, and in only 8.8% of this series was there delay in healing of

stumps. Emphasis should be laid on the necessity for penicillin-sensitivity tests before operation.

Careful attention should be paid to operative technique, and operation should not be undertaken in the presence of active inflammation or profuse discharge from a granulating wound.

My thanks are due to the Director-General, Medical Services, Ministry of Pensions, and the Medical Superintendent at Chapel Allerton for permission to publish these series; also to my colleagues—especially Mr. A. Lawson Light, who performed some of the operations—for helpful criticism, and to the pathological department and office staff for their assistance.

DESCENT OF THE TESTIS IN RELATION TO TEMPERATURE

BY

ALEC W. BADENOCH, M.D., Ch.M., F.R.C.S.

Wing Commander, R.A.F.V.R.; Surgeon, Metropolitan Hospital, London

The abdominal position of the foetal testis was known to Galen (Frankl, 1895), but Baron Haller (Hunter, 1837) and John Hunter (1837) really first focused attention on this point and began the stream of literature, which has flowed on in such quantity from observers, on all aspects of development and descent. The facts are few and not greatly in dispute; the fancies prolific and constantly recurring.

The Position in Mammals

The descent of the testis is peculiar to mammals. In all animals, up to and including reptiles and birds, the testis lies high up in the abdomen, and in some of the more primitive mammals, such as the Monotremata (duck-billed platypus and spiny ant-eater), this position persists. In the higher groups the testis lies in the false pelvis. Most of the Edentata (sloth, ant-eater, and armadillo), some of the Insectivora (shrew), the Cetacea (whale and porpoise), and the Sirenia (seacows) have primary abdominal testis with no inguinal fold. In marsupials (kangaroo and wallaby) the testis lies in the suprapubic region, in a well-developed pouch with a closed processus vaginalis. According to Andrews and Bissell (1934) this is really inguinal and represents the earliest extra-abdominal position. In rodents, some of the Insectivora (mole and hedgehog), and Cheiroptera (bats) the testis is intra-abdominal in the resting phase of the sexual cycle. During the rutting season it is extruded by unstriated and retracted by striated muscle; there is no true vaginal process. In the Ungulata, Carnivora, and Primates there is a true vaginal process, and the testis is extra-abdominal. The elephant is an exception, the testis being inside the abdomen; and in some—e.g., the stag—the testis is retracted at other than the rutting season. It has been said that the processus vaginalis is occluded only in man and some of the higher monkeys, but occlusion must sometimes occur in other animals, since hydrocele has been reported in dogs and bulls.

Cause of Migration

There is no physiological reason why the testis should not leave its primitive position in the abdomen. Certainly as regards its spermatogenic function it plays no part in the general economy of the body, and, as Crew says, it belongs to the race rather than to the individual. When discussing the problem of its extra-abdominal position Herbert Spencer (1866) wrote: "We cannot consider it an adaptive change, since there seems no way in which the production of sperm cells, internally carried on in a bird, is made external by adjustment to the changed requirements of mammalian life. Nor can we ascribe it to the survival of the fittest, for it is incredible that any mammal was over-advantaged, in the struggle for life, by this changed position of the organ." I think all would be in agreement with the last sentence, but the previous one is now known to be incorrect.

Influence of the Scrotum on Spermatogenesis

In any animal in which the testis normally descends, in order that it may attain full development and function, it must reach and occupy the terminal part of its destined course. Griffiths (1895) showed that if the testis of a dog was replaced in the