POLIOMYELITIS IN BRITISH AND AMERICAN TROOPS IN THE MIDDLE EAST

THE ISOLATION OF VIRUS FROM HUMAN FAECES

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Van Rooyen and Morgan in 1943 called attention to poliomyelitis as a *military disease* in the Middle East. Since 1940, cases of this disease among British troops have not been uncommon; many have been severe, and a high percentage have been fatal. From several of these fatal cases (occurring in 1942 and 1943) the virus of poliomyelitis has been isolated by them from the central nervous system, and the properties of some of these strains have also been studied by Schlesinger *et al.* (1943) in the United States. The present report is concerned with a series of attempts to isolate poliomyelitis virus from the *stools* of typical (and borderline) cases of poliomyelitis, which occurred during 1943 among British and American troops stationed in the Middle East—particularly in Libya, Egypt, and Palestine. The tests have been undertaken to determine: (i) their local value as a confirmatory diagnostic procedure; and (ii) whether these adult cases (which have occurred for the most part sporadically) harbour the virus in the intestinal tract in the same manner as do juvenile cases in areas where the disease is more apt to be epidemic.

Prevalence of Poliomyelitis in the Middle East

From the onset of this work we have been concerned with the circumstances under which this peculiarly severe type of poliomyelitis has occurred in civilian as well as military populations of the Middle East during recent years. In *Egypt* there is a dearth of published information on this point. Reports to the Egyptian Ministry of Health appear inadequate, for only a few cases—nearly all of them fatal—have been listed during recent years. Thus in the year 1938 the Egyptian Ministry of Health reported, for all of Egypt (16 million people), only 3 cases of poliomyelitis, with 2 deaths; and in 1939, 8 cases and 8 deaths. To supplement this information we have obtained data from two prominent Cairo paediatricians,† who agree that poliomyelitis is "not uncommon" in Egypt—a fact which becomes evident from a glance at Table I, which gives the number of new cases seen annually at the Children's Hospital Dispensary of Cairo.

TABLE I.—*Incidence of Poliomyelitis at the Children's Hospital Dispensary, Cairo**

Year	New Cases	Total New Patients Admitted to Dispensary	Approx. Rate per 1,000 Admissions
1933	71	58,000	1·2
1934	74	73,000	1·0
1935	24	77,000	0·3
1936	48	100,000	0·5
1937	22	110,000	0·2
1938	96	116,000	0·8
1939	41	122,000	0·3
1940	149	148,000	1·0
1941	110	160,000	0·7
1942	201	165,000	1·2

* Data kindly furnished by Prof. Shawki.

Data in this table indicate a fairly high endemic rate for poliomyelitis in the civilian population of Cairo; probably it is greater than hitherto suspected. There have been fluctuations from year to year, but the disease has not appeared in epidemics during this period. Furthermore, in contradistinction to the experience in temperate climates, it is more of an all-year-round disease in Egypt, with maximal incidence in March, April, and May, and again in October.

Information about the civilian age groups involved is scanty, but most of the cases listed in Table I have been in patients under 5 years of age. Poliomyelitis in the native Egyptian *adult* seems to be rare, and from verbal accounts no cases have been seen recently at the Military General Hospital in Cairo. The local juvenile cases have usually been mild and severe bulbar cases rare. Prof. Shawki has seen only 2 cases of severe acutely ascending paralysis in local children.

In *Palestine* some information has been published by Levy (1937), who concluded that there, also, poliomyelitis was not uncommon, in that for the 20-year period 1915–34 he was able to collect from the records of orthopaedic dispensaries and physicians a series of 215 paralytic cases. From these data he estimated the average incidence of poliomyelitis to be only slightly lower than that of the United States! On the other hand, it was not common among the large native Arab population, the highest prevalence being among Jews (12.3 per 100,000)—an average rate 25 times that noted among Moslems. Seasonally, as in Egypt, there were two periods of increased incidence—one in May and June and another in October and November. And, again as in Egypt, the disease was largely one of infants—85% of the cases being recorded in children under 4 years of age. Adult cases were not mentioned.

This is the present setting in the Middle East, where many cases have occurred among British troops. To quote from van Rooyen and Morgan's report: In 1941 a total of 74 cases were notified as acute poliomyelitis or encephalitis in the M.E.F., and of these 19 were fatal; in 1942 there were 32 cases, with 14 deaths. The rate among American soldiers stationed in the Middle East (during the first 10 months of 1943) has been more than 10 times that recorded in the United States (see Table II) for a similar period of time.

TABLE II.—*Poliomyelitis Rates per 1,000 in the U.S. Army*

Year	In the Middle East	In the United States
1940	—	0·02
1941	—	0·02
1942	?	0·03
1943	0·425*	0·03†

* To Oct. 1, 1943. † To Sept. 12, 1943.

Clinical Epidemiology

Contacts and living quarters were investigated in 10 military cases of poliomyelitis or polio-encephalitis, which were probably acquired in Cairo between May 1 and Oct. 15, 1943. The cases were ubiquitous as to their place of origin. No two patients seemed to have been in contact. No civilian cases were discovered among adults or children living in close proximity to the patients' quarters. This does not mean that epidemics of poliomyelitis do not occur in the Middle East. Caughey has described, in an unpublished report, an epidemic of poliomyelitis which occurred in 1941 among New Zealand troops stationed in Egypt. Subsequently there have been other small localized outbreaks. During the summer of 1943 there were two of these—in Libya and in Tripoli. We did not have the opportunity of examining these situations first-hand.

Isolation of Virus from Stools

During the past five or six years methods of testing stools of poliomyelitis patients for virus have been revived by Trask *et al.* (1938) for purposes of diagnosis and epidemiological study. Recent published reports, of which there are many in American medical literature, now record positive isolation experiments in well over 100 cases. Advantages of testing stools rather than nasopharyngeal washings in this disease rest on the fact that in the average juvenile case the virus remains in the intestinal tract (during convalescence) for much longer periods (roughly 20 days) than it does in the nasopharynx

* From the Neurotropic Virus Disease Commission (Board for the Investigation of Influenza and Other Epidemic Diseases in the Army, Preventive Medicine Service, Office of the Surgeon General, U.S. Army).

† We are indebted for this information to Dr. Ibrahim Shawki Bey, Professor of Paediatrics, Faculty of Medicine, Cairo; and Dr. Edouard Debbas, Physician-in-Chief for Diseases of Children at the Israelite Hospital in Cairo.

(roughly 2 to 4 days). Most of the recent work by Trask *et al.* (1938 and 1940), Kramer *et al.* (1939), Howe and Bodian (1940), Kessel *et al.* (1941), and Sabin and Ward (1941a) in the United States; by Kling *et al.* (1939) in Sweden; and by Lépine *et al.* (1939) in France has been done on children, and it has been found to be easier to isolate virus from stools of young children (under 8 years old) than in children over this age. Information with regard to the presence of virus in the stools of adult poliomyelitis patients is far more limited.

Necropsy studies by Sabin and Ward (1941b) and by Kessel *et al.* (1941) in their series of fatal cases (most of which were in the second week of the disease) have also pointed to the intestinal tract as a site of predilection for the virus. They found that in this stage of the disease the virus was distributed predominantly in two systems: (*a*) certain regions of the nervous system; and (*b*) the walls of the pharynx and ileum, and the intestinal contents. These may not be the only locations at all times during the disease, but they are the most prominent after serious lesions have become established.

The *epidemiological* significance of the presence of poliomyelitis virus in the stools of human cases remains unsolved, for as yet the portal or routes of entry of the virus are unknown. Modern research has indicated that the nasal mucosa and olfactory bulbs can no longer be regarded as the main avenues of infection, because human necropsies have failed to reveal in these bulbs characteristic lesions which were shown to be present by Sabin and Olitsky (1937) when the disease is induced experimentally in the monkey by instillation of virus into the nostrils. Indeed, if analogy existed between the human and the experimental disease, then it would seem that infection through the pharyngeal or gastro-intestinal tract should be seriously considered, because of the relative ease with which chimpanzees and cynomolgous monkeys may be infected by feeding them with virus.

Of further and possible epidemiological significance is the fact that the virus has been isolated from samples of sewage collected by Paul *et al.* (1940) in the United States, and by Kling (1940) in Sweden, during epidemics. Of more interest is the recent discovery of its presence in flies collected at different epidemic centres. This has been noted by Paul *et al.* (1941), by Sabin and Ward (1941c), and by Toomey *et al.* (1941). Unfortunately, these findings do not indicate how the disease is disseminated, but they reopen the question whether poliomyelitis may not be legitimately placed among the excremental infective diseases pending such times as it may be proved otherwise. In fact, the evidence for other means of infection is appreciable, for poliomyelitis can be reproduced by injecting infective material *subcutaneously* in monkeys, as has also been the case in accidental human infections (Leake, 1935). Consequently, in view of this latter feature, one cannot ignore the possibility of the disease being transmitted by a biting insect. The need for intensive study on the widest possible scale is thus apparent.

Clinical Material

Stool specimens from 35 patients (and contacts) were tested; 17 of these were American and 18 British.* Four different clinical types of case were chosen for study:

(I) Fifteen typical cases of *poliomyelitis* were tested in all, of which 10 were fatal.

(II) Five cases diagnosed *polio-encephalitis*, with a short (3- to 4-day) febrile course and paralyses *limited to the cranial nerves*. In general the *epidemiological* background and circumstances in which these cases were contracted were suggestive of poliomyelitis. Positive spinal-fluid findings consisted of pleocytosis varying from 30 to 60 cells (about 60% lymphocytes) and slightly increased protein content.

(III) Six cases were diagnosed *acute benign lymphocytic meningitis*. Paralysis was not noted except in an occasional case in which there was a transient sixth-nerve lesion. The cell count in the spinal fluid ranged between 20 and 80 cells. In none of these patients did the fever last more than 4 days, and so for this and other reasons we have considered the diagnosis of lymphocytic choriomeningitis to be improbable.†

(IV) Six cases in which localized *neuritis*, usually involving one or more limbs (generally the upper arms), has often followed a brief period of diarrhoea or fever, or both. A description of the syndrome as seen in New Zealand troops has recently been given by Burnard and Fox (1942). The spinal-fluid findings in our series have usually been normal.

(V) Three poliomyelitis contacts.

Laboratory Methods

Stool specimens were as a rule kept refrigerated (or preferably in the frozen state at −60 to −70° C. in a refrigeration box containing solid CO_2) until ready to be tested. In most instances this period of preserving the sample before its inoculation did not exceed two weeks. Occasionally, when stool specimens were not readily obtainable, enema washings were substituted. In 7 instances colon contents were obtained at necropsy. The usual clinical course of these fatal cases was rapid, and by the second or third day constipation and profound prostration were such that in a large number of instances specimens of faeces could be obtained only at necropsy. In these circumstances a loop of colon was tied off with string, and the loop was excised and placed in the ice-box (for 24 to 36 hours) until the contents could be removed under sterile conditions.

In preparing faecal material for monkey inoculation the following procedure was used:

A 10% suspension in sterile distilled water (using at least 5 or 6 g. of solid or semi-solid stool) was prepared and allowed to settle at room temperature; the supernatant fluid, amounting to about 50 c.cm., was then divided in half (parts A and B). Part A was kept at ice-box temperature and instilled into the nostrils (in 3-c.cm. amounts) of a single monkey on three or four successive days; part B was immediately centrifuged for 20 minutes at about 2,000 r.p.m., and to the supernate 15% ether was added as a bactericidal agent. The etherized suspension was kept refrigerated for 48 or 72 hours and inoculated intra-abdominally in amounts of 15 to 20 c.cm. into the same monkey. This concentration of ether was usually sufficient to destroy or diminish the number of bacteria in the suspension to proportions small enough to permit intra-abdominal injection of 15 or 20 c.cm. of stool extract without fear of inducing peritonitis.

Daily rectal temperatures and exercise records were taken for a period of four weeks on all monkeys inoculated in this manner. A positive result was based on the following criteria in the inoculated animal:

1. "*Clinical.*"—Signs of the experimental disease—viz., fever, tremor, weakness, paralysis, and prostration, all or some of which may be present in varying degrees.

2. *Pathological.*—The presence of characteristic histopathological lesions in the medulla and various levels (cervical, dorsal, and lumbar) of the spinal cord.

With the exception of the experiments by van Rooyen and Morgan, who isolated poliomyelitis virus from the human spinal cord in grivet monkeys and baboons, the types of monkey used in these tests on faecal material have to our knowledge seldom before been employed in poliomyelitis work. Five different species were used: (i) grivet monkeys, *Cercopithecus griseoviridis*; (ii) Central African vervet monkeys, *Cercopithecus aethiops centralis*; (iii) small immature Abyssinian baboons, *Papio hamadryas*; (iv) Hussar monkeys, *Erythrocebus patas*; (v) the bonnet monkey, *Macacus radiata.*

Four of these species (Nos. i–iv), all from East Africa, were shown in these experiments to be susceptible to infection with poliomyelitis virus. Of these we have reason to believe that the baboons are the least susceptible by the various routes of inoculation used. The fifth variety, or bonnet monkey (from India), of which we had only three specimens, was not adequately tested. In the whole series of experiments (including passage experiments) 44 monkeys were used, 6 of the animals twice.

Results

A summary of the tests performed appears in Table III. In most instances the results have been listed according to the day of disease on which the stool was collected.

Poliomyelitis Cases.—Of the 15 cases tested, the stools (or colon contents) in 9 were positive for poliomyelitis virus.

* We are indebted in particular to Major C. R. Amies, R.A.M.C., for many of these specimens. Other members of the R.A.M.C. to whom we are indebted for the collection of specimens include Major H. K. Fidler, Lieut.-Col. J. H. Fisher, Major J. E. Caughey, and Major R. S. Illingworth.

† Likewise, in precisely similar cases, efforts to demonstrate specific neutralizing antibodies in the blood have all been unsuccessful.

All of these positive cases proved to be fatal. In one of them the stool was obtained before the patient's death. In one of the 15 cases the result was unsatisfactory owing to the premature death of the monkey. These results suggest that

TABLE III.—*Results of Stool Tests for Poliomyelitis Virus*

Type of Case	Total Patients	Day of Disease Stool Collected	No. of Patients	No. Positive for Polio. Virus	No. Neg.	Unsatisfactory Tests*
Poliomyelitis ..	15	3–10	9	8 } 9	1 } 5	0
		11–18	6	1	4	1
Polio-encephalitis ..	5	9–79	5	0	5	0
Poliomyelitis contacts	3		3	0	2	1
"Benign lymphocytic meningitis"	6	4–6	5	0	4	0
		7–21	1	0	1	0
Neuritis	6	6–8	4	0	4	0
		9–14	2	0	2	0

* The experiment was considered unsatisfactory if the monkey died (without developing poliomyelitis) before the termination of the 4-week (post-inoculation) period of observation.

the amount of virus present in the intestinal tract was greater in the more severe than in the milder cases of poliomyelitis in this series—a finding which has not to our knowledge received comment before, and one which may not hold true for juvenile cases. Another point, however, in the interpretation of the high percentage of positive results from the fatal cases (which for the most part were fulminating in type) is that most of the "stools" were collected *earlier* in the disease (on the third to tenth day) than in the other poliomyelitis cases. It has long been recognized that the chances of obtaining positive results are greater during the first than during the later weeks of the disease.

Other Cases (Groups II, III, and IV).—All tests for virus in the stools from cases other than typical poliomyelitis proved negative. Several of the monkeys developed fever without symptoms of myelitis and were killed. Histological examination of the spinal cord proved negative, and no doubtful positive results were obtained; but, needless to say, failure to find poliomyelitis virus in such cases does not necessarily exclude the disease.

Summary

The stool test as a confirmatory means of diagnosis in clinical poliomyelitis has been used in 15 cases of typical poliomyelitis, 17 atypical cases, and 3 contacts, which occurred in British and American troops stationed in the Middle East during 1943.

From the 10 *fatal* cases of poliomyelitis the isolation of virus from stools was accomplished in 9 instances.

Negative findings have been encountered in the remaining 5 (non-fatal) cases of poliomyelitis (one test was unsatisfactory), and negative results were likewise encountered in 20 "atypical" cases (and contacts)—viz., 5 cases of polio-encephalitis, 6 cases of "acute benign lymphocytic meningitis," 6 cases of neuritis, and 3 poliomyelitis contacts. The negative virus findings do not wholly exclude the possibility of poliomyelitis.

Grivet and vervet monkeys, obtainable in East Africa, are highly susceptible to experimental infection with poliomyelitis virus.

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SYMPATHECTOMY AND STERILITY

BY

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A patient upon whom I performed a lumbar sympathectomy some years ago was recently on trial on a charge of "incest." His defence was that as the operation had rendered him sterile it was impossible that he could be the father of his daughter's child. This information he had culled from a surgeon whom he had consulted subsequent to the operation, but before the alleged crime was committed. As removal of part of the lumbar sympathetic chain is now performed with considerable frequency, and in view of possible legal implications, it is time that the question of any resultant sterility should, if our knowledge warrants it, be unequivocally settled.

The physiologists have a good deal to teach us regarding the mechanism of ejaculation and its dependence upon the autonomic supply to the base of the bladder. The course taken by the sympathetic supply is apparently a long one down through the so-called "lumbar splanchnics" and the pre-aortic plexus, coming particularly from the first lumbar contribution. As this part of the lumbar chain is not usually removed in the ordinary operation, the sympathetic fibres concerned with ejaculation should escape. But whatever the physiological and anatomical considerations, the practical outcome is whether in fact patients who have submitted to the operation can procreate and whether their semen is normal.

It has proved more difficult than would be expected to get definite evidence to answer the first question. For reasons unconnected with physical sterility these patients appear very rarely to become parents after the operation. However, I know of two cases in which a child was born subsequent to the operation. The second question is more readily answered. I have examined several specimens of semen obtained from such patients which to my inexperienced eye appeared normal, but a more complete examination of some of the specimens has been carried out by Dr. D. Embleton, to whom I should like to express my thanks. Sample results are as follows:

Examination of Semen after Sympathectomy

Case 1.—Aged 42; proximal type of thrombo-angiitis obliterans; one year after operation. Volume of seminal fluid, 1.5 c.cm.; *p*H, 8.0; colour, greyish white; number of spermatozoa, 212 millions per c.cm.; differential count, normal forms 54%, abnormal 46%; hanging drop, about 50% motile.

Case 2.—Aged 50; distal type of thrombo-angiitis obliterans; ten years after operation. Volume of seminal fluid, 1.5 c.cm.; colour, greyish white; number of spermatozoa, 162 millions per c.cm.; hanging drop, 83% motile.

This should be sufficient to convince the most sceptical jury in a criminal case.

Comment

The thoroughness of the sympathectomy (which did not include the first lumbar ganglion) in all cases was, as usual, confirmed by microscopical study of the parts removed, as well as by the subsequent clinical history and sweating tests. This type of sympathetic denervation therefore produces neither sterility nor impotence, and so we can set at rest the minds of those who may hesitate to suggest lumbar sympathectomy, when otherwise advisable, on account of the fear of sterility.

It remains a philosophical paradox that a mechanism as characteristically parasympathetic in its functioning as sexual intercourse should require powerful sympathetic activity for its consummation. Possibly the paradox really lies in our conception of an essential opposition in the action of the two systems, an idea encouraged by much physiological teaching.

A comprehensive statistical and epidemiological review of typhoid fever in Egypt from 1935 to 1942 was contributed by Dr. A. M. Kamel and Dr. G. A. Messih to the *Journal of the Egyptian Health Association* for December, 1943. A reprint of this review can be seen in the library of the B.M.A.