relative importance of these two sources of the virus. In the few instances during this outbreak where there was evidence of the prolonged or intimate personal contact, usually associated with faeces-spread diseases, the circumstances strongly suggested a nasopharyngeal spread of infection. Five of such instances are described in connexion with the incubation period.

Preventive Measures

The experience in Eccles was that schools played no significant part in the spread of infection. Two-thirds of the total cases and one-half of the cases among school-children occurred during the time the schools were closed for the summer holidays. No infection could be traced to school contact.

Notification should include abortive or non-paralytic cases. It has already been noted that these cases are many times more prevalent than the frank paralytic cases, are known to be infectious, are rarely recognized as such, and play a major part in the spread of infection—certainly a much more important part than the frank paralytic case in hospital.

It would be an advantage if the present regulation requiring the separate notification of polio-encephalitis and poliomyelitis was superseded by one reverting to the more accurate and comprehensive term of polio-encephalomyelitis, with perhaps a further subdivision into paralytic and non-paralytic or abortive cases. This would encourage more frequent and earlier notification and greatly assist the medical officer of health or those responsible for control and prevention.

As over two-thirds of the cases in England and Wales occurred in persons over the age of 5 the term "infantile paralysis" must now be regarded as a misnomer.

The isolation period usually recommended is three weeks (Memo. to Ministry of Health, 1947). In view of the findings of Horstmann *et al.* (1944, 1946) that 50% of patients are still excreting the virus in the stools between the third and the fourth week, this period is theoretically too short. The collected findings of Brown *et al.* (1948) that 20% of family contacts excrete the virus would indicate that isolation measures should, ideally, include the whole family.

Viewing in retrospect the wide distribution of cases (Map 4) and the high attack rate (Table I) one cannot help feeling critical of the efficacy of the accepted preventive measures. It must be realized, however, that although these measures are not likely to stop an epidemic they will certainly slow down its spread. Since epidemics nearly always abate with the onset of cold weather; this "slowing down" may be expected to result in a large number of susceptible persons remaining untouched who would otherwise become permanent cripples.

Summary

During the 1947 poliomyelitis epidemic the borough of Eccles suffered the highest attack rate of any local authority district. There were 46 cases, giving an attack rate of 1.09 per 1,000 of the population. The case mortality was 6.5%.

The incubation period was 7 to 13 days. Only one family had more than one frank case. There was only one instance of a frank case-to-case contact.

The epidemic was confined for nearly six weeks to the western half of the borough by a canal which restricted communications between the two halves.

The results of field studies indicated that the chief factor in the spread of infection was human contact, in which abortive cases and healthy carriers played the major part. The presence of the virus in the nasopharynx of patients and carriers was of much more importance for the spread of infection than was its presence in faeces.

A survey undertaken revealed the presence of numerous abortive cases, especially in close proximity to frank cases, and suggested that of every 20 persons who showed clinical signs and symptoms of infection less than one developed into a frank paralytic case.

Suggestions to improve the present system of notification are made, particularly the necessity for notifying abortive cases.

I am indebted to Dr. J. E. Spence, M.O.H. to the Borough of Eccles, for his invaluable encouragement and advice, and to members of his staff for assistance in the field work and in the preparation of the charts.

REFERENCES

- Brown, G. C., *et al.* (1948). *J. exp. Med.*, **87**, 21.
 Flexner, S., *et al.* (1913). *J. Amer. med. Ass.*, **60**, 201.
 Horstmann, D. M., Melnick, J. L., and Wenner, H. A. (1946). *J. clin. Invest.*, **25**, 270.
 ———, Ward, R., and Melnick, J. L. (1944). *J. Amer. med. Ass.*, **126**, 1061.
 Howe, H. A., *et al.* (1944). *Proc. Soc. exp. Biol.*, N.Y., **56**, 171.
 McFarlan, A. M., Dick, G. W. A., and Seddon, H. J. (1946). *Quart. J. Med.*, n.s., **15**, 183.
 Memo. to Ministry of Health (1947). *British Medical Journal*, **2**, 141.
 Paul, J. R., and Trask, J. D. (1932). *J. exp. Med.*, **56**, 319.
 Pearson, H. E., and Rendtorff, R. C. (1945). *Amer. J. Hyg.*, **41**, 179.
 ——— *et al.* (1945). *Ibid.*, **41**, 188.
 Registrar-General (1947). Quarterly returns of infectious diseases.
 Rhodes, A. J. (1947). *Bull. Hyg.*, **22**, 362.

THE OEKOLOGY OF POLIOMYELITIS IN A MILITARY CAMP IN 1947

BY

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The widely held view that cases of overt poliomyelitis are to be regarded as the severer examples of a carrier epidemic makes the recognition of early non-paralytic cases of special importance (Memo. by M.O.s to Ministry of Health, 1947).

This paper is concerned with the search for such a carrier epidemic at Catterick Camp, where paralytic cases occurred during the 1947 epidemic. The population at risk can be broadly classified as follows: 13,500 to 14,500 young soldiers under training living in huts each containing 20 beds, and 3,540 inhabitants of 1,169 Army quarters—1,785 adults, 1,612 children under 15, and 143 children over 15.

Towards the end of June a case of poliomyelitis in the pre-paralytic state was isolated in the Military Hospital, and two other patients who did not develop paralysis were similarly treated because of meningism. After receiving information about another paralytic case in a near-by camp instructions were issued to admit all suspicious cases to hospital. This procedure resulted in the admission of eight paralytic cases, including a fatal one, ten probably abortive cases, and eight suspects. The paralytic cases included five young soldiers and one child from the camp area; four of these became ill between Aug. 2 and 26, one in June, and one in October.

Symptomatology of Paralytic Cases

An acute onset with headache, stiffness and pain in the back, occasional vomiting, and twitching of the muscle groups which later became paralysed was the rule. However, five of the eight paralytic cases had been slightly indisposed for about a week; only one had sought advice, and he had felt well enough to go on leave hitch-hiking the day before he was finally taken ill (Table I).

Objectively the early cases presented with pyrexia ranging from 101 to 102° F. (38.3 to 38.9° C.), slight drowsiness,

TABLE I.—*Paralytic and Fatal Cases of Poliomyelitis*

Case	Age in Years	Service in Months	No. Days Prodromal Illness	Date of Onset of Acute Symptoms	First Date of Observation	No. Days Headache before Observation	No. Days Backache before Observation	No. Days Objective Spinal Rigidity	Maximal Temp. (° F.)	No. Day Fever Observed	Days after (5) C.S.F. Examined	Mg. Protein per 100 ml. in C.S.F.	No. Leucocytes in C.S.F.	Interval in Days between Acute Onset and Paralysis	
P1	18	6	10	2/3	5/3			4		4	4	40	240	0	Gross weakness of right glutei, hamstrings and shin muscles, and right triceps
P2	18	9	10	16/6	16/6	1	2	7-14	102.4	4	1	45	222	2	Transient retention of urine. Paralysis of left shin muscles. Gross weakness of all other muscles of left leg. Weakness of muscles right hip and knee
P3	16	0	14	2/8	3/8	0	1		101	8	2	80	190	4	Gross weakness left abdominal muscles, flexors and abductors right thigh, and right shin muscles
P4	26	19	2	6/8	6/8	2	2	3	100.8	4	Same day	95	26	1½	Weakness right biceps. Gross weakness all muscles moving left hip
P5	12	0	0	27/8	28/8	½	½	3	102	3				4	Slight weakness in flexion and dorsiflexion of left ankle
P6	19	18	0	28/8	12/9	1	1		100						Weakness all movements of right ankle, slight weakness right hip. Treated in lines; complaining of stiff neck; paresis discovered only day of admission to hospital, Sept. 12, but probably present on Sept. 6. Treated in C.R.S. Aug. 28 to Sept. 6
P7	21	24	7	5/10	6/10	½	½	28	102.4	4	2	70	260	2	Paralysis of all muscles of left shoulder. Weakness left biceps, triceps, right triceps, serratus. Transient diplopia
D1	18	9	7	?	22/7	6	+	1	101.5	1					Respiratory distress occurred within one hour of observation; died of respiratory failure within 24 hours

and furred tongue. The most characteristic sign was stiffness of the back, especially pronounced in the lumbar and dorsal spine, where the immobility was almost complete, making the body rigid like a plaster cast. Limitation of neck flexion prevented the chin being flexed more than half-way to the chest wall; Kernig's sign was present after flexion of 45 degrees. The combination of these factors made it impossible for the patients to sit up in bed. Elicitation of these signs usually produced pain in the back in either the mid-dorsal or the lumbar region. The skeletal muscles were often tender on palpation, and localized pains occurred in the regions later paralysed. The pyrexia became remittent with maximal temperatures varying between 100.8 and 102° F. (38.2 and 39.1° C.) and lasting three to six days. Only one case developed anything resembling "dromedary" pyrexia observed in certain other epidemics (McFarlan, Dick, and Seddon, 1946). This child (Case P5) had fever of 102° F. (38.9° C.) for three days and meningism, then after two symptom-free days developed a minor palsy of one leg with recrudescence of pyrexia to 99° F. (37.2° C.).

Six of the eight paralytic cases were treated at complete rest in bed within a few hours of developing acute symptoms. The early history of the fatal case (D1) is more obscure, but it is possible that he delayed reporting sick for a week. The palsy in the seven surviving paralytic cases occurred towards the end of the feverish period, between two and four days after the onset of acute symptoms. In only two cases was this palsy mild enough to leave any hope of recovery. This finding is in sad contrast with those of Ritchie Russell (1947) in a much larger series. He divided his cases into those in which palsy was mild enough to allow hope of full recovery and those in which residual impairment of function was to be expected, and observed that 18 of the first group had had rest in bed within 24 hours of the development of acute symptoms and 19 of the second had not had this advantage; the reverse had occurred in only three and two patients respectively. It could be suggested that, as he examined convalescents, many mild cases that did not take to bed had escaped his notice.

The cerebrospinal fluid in the five paralytic cases examined showed a pleocytosis ranging from 26 to 260 cells

per c.mm., the cells being chiefly lymphocytes. The protein content of the fluid varied from 40 to 95 mg. per 100 ml. (Table I).

Differential Diagnosis

It is important to stress that before the development of the palsy poliomyelitis can only be suspected. A further group of 16 patients from the camp so resembled the paralytics in their earlier stages that they were suspected of being cases of poliomyelitis. In eight of these the discovery of other disease, presumably adequate to account for their symptoms and signs, probably refuted the diagnosis of poliomyelitis. Only two of them had abnormal cerebrospinal fluid; both fell ill in the month of June, and the remainder in September and October. It seems probable that, as Warin (1947) postulated for Leeds, the known occurrence of poliomyelitis influenced the diagnosis in later cases.

Presumed Abortive Cases

Ten of the suspected cases never developed sufficient signs or symptoms to warrant an unequivocal diagnosis. Their main interest lies in the fact that six of them occurred in Catterick Camp between July 23 and Aug. 28 and so coincided with the paralytic cases. Their illnesses were characterized by backache, headache, stiffness in the neck, and fever. In two meningism occurred; three vomited, and another two developed doubtful paresis of short duration. In six of these patients subjected to lumbar puncture the cerebrospinal fluid was found to be abnormal (see Table II).

The clinical findings in these 10 patients are similar to those labelled non-paralytic poliomyelitis by Casey, Fishbein, Abrams, and Bundesen (1946) among 14 children who became ill five to 25 days after being in contact with the same febrile case of poliomyelitis. Andelman, Fishbein, Casey, and Bundesen (1946) at the same time examined the cerebrospinal fluid of 19 contacts suspected of suffering from subclinical poliomyelitis and found the protein content to be above 45 mg. per 100 ml. in 79%, as against a similar finding in only 10% of 10 non-contact control children who had suffered a febrile illness not thought to be due to the virus of poliomyelitis.

TABLE II.—Cases of Short Fever resembling Initial Stages of Poliomyelitis

Case	Sulphonamide Administered	Age	No. Day Prodromal Illness	Day of Onset of Acute Symptoms	Admitted to Hospital	Headache (Days before Admission)	Backache (Days before Admission)	Stiffness in Neck	Abdominal Pain	Nausea	Vomiting	Sore Throat	Congestion of Fauces	Cough	Guarding of Abdominal Muscles	Furred Tongue	Objective Rigidity of Spine	Mild Mental Confusion	Maximum Temp. (° F.)	No. Days Fever after Admission	No. Days after (4) C.S.F. Examination	Mg. % Protein in C.S.F.	No. Leucocytes in C.S.F.	
A1	+	17	2	25/6	25/6	2		+	+	+		+		+			+		102	4	2	60	150	Dysphagia for solids for about three weeks after fever
A2		24	2	1/7	1/7	2	2		+						+		+		100-2	1				
A3		19	2	14/7	14/7	2	2										+		104	10	2	35	27	Pain on moving eyes across; first symptoms lasted days
A4		19	3	23/7	23/7	3		+									+		101-4	3				Doubtful weakness of left peroneals on eighth day
A5	+	22	2	24/7	24/7	2		+			+	+	+				+	+	102-4	2	Same	50		Hyperaesthesia of skin; knee-jerks absent two days
A6		21	0	28/7	28/7	+					+							+	102-4	2	Same	45	1	
A7		19	4	20/8	22/8	5	3				+								103	3	2	45	4	Stiffness and aching limbs
A8		19	3	21/8	21/8	3													103	2				
A9		18	2	24/8	25/8	2	2				+								100-8	1				Knee-jerks absent at one examination only
A10		15	9	20/9	21/9	2	9				+						+		100	2	1	60	16	Vertigo and photophobia

Cases A1 and A10 came from near-by units. Case A2 : A married corporal living in quarters in camp. Case A5 : Cerebrospinal fluid contained 440 red blood cells per c.mm.

Epidemiology

No evidence of contact between any of the paralytic cases in Catterick was found, and no two cases came from the same unit. In one instance a presumed abortive case (A5) used the same wash-place as a paralytic patient (P4) and sickened 10 days after the latter was removed to hospital; a 13-day interval was also observed between two abortive cases (A2 and A3) belonging to the same regiment who were probably not in contact.

No infection of the nursing personnel attending the cases was observed. Most of these nurses were young male orderlies of the same age group as the patients, and no masks were worn. In view of McAlpine's (1945) report of fatal poliomyelitis in two nursing sisters attending cases in India, more precautions might have been advisable. One member of the hospital staff, a clerk aged 19 (Case A4), became ill with presumed abortive poliomyelitis, but his only contact with a case or suspected case occurred four or five hours before he developed acute symptoms.

Up to the middle of August the paralytic cases and suspected non-paralytic cases occurred singly or in pairs at intervals of approximately nine to 14 days (see Graph);

Graph showing dates of onset of cases. P=Paralytic poliomyelitis. A=Presumed abortive poliomyelitis.

later this pattern was lost. This type of case-spacing is described by Casey, Fishbein, Abrams, and Bundesen (1946), who postulate carrier waves in which only 2% of the cases develop paralysis, the waves being due to an incubation period of six to 14 days as observed by Casey (1942) and Aycock and Kessel (1943).

Search made for such carrier waves by examination of sick reports and admissions suggested that the diagnoses of tonsillitis, pharyngitis, coryza, and short fever were applied to different clinical manifestations of the same infection, as several of these conditions were often recorded simultaneously in the same unit, which would later be free of similar cases for some weeks. During the period June to October the weekly incidence of the aggregate of these diseases in the camp was between 0.07 and 1.1 cases per 1,000, which is not greater than in previous years. Twenty-four of these cases were thought to be serious enough for admission to hospital as opposed to the Camp reception

station, and from the throats of 17 of these β -haemolytic streptococci were cultured.

There were some ten large units of over a thousand men in the camp. One of these, which had furnished a case of paralytic poliomyelitis, produced only two instances of minor fever, and these at an interval of over three months from the case of poliomyelitis. Another similar unit, which had the highest incidence of minor fevers and actually also had the highest weekly record in the camp—namely, 4.5 per 1,000—also had one case of paralytic poliomyelitis. In other units producing paralytic cases the incidence of minor fevers was between these extremes, and two large units with relatively high instances of minor fever had no cases of poliomyelitis and no suspected cases.

Thus it would appear that these minor fevers were not related to the transmission of poliomyelitis. But as five of the paralytic patients were indisposed for a week before finding it necessary to seek medical advice it is possible that similar cases of indisposition were widespread and unrecognized; or, alternatively as postulated by McFarlan, Dick, and Seddon (1946), apparently healthy males can act as carriers of the epidemic.

Only one case (P5) and no suspected case occurred among the 1,612 children in the camp area. Preliminary reports of the English epidemic of 1947 (McAlpine, 1947), suggest that approximately 20% of notifications have been of patients over 15 years of age; even so, the disproportion is probably significant.

Three of the young soldiers developing paralytic poliomyelitis came from professional or middle-class families and two were from superior artisan families. Bernstein, Clark, and Tunbridge (1945), observing the same phenomenon among Service personnel in Malta, postulated that these classes had been more sheltered from the virus of poliomyelitis in their youth and hence were more susceptible. The young soldiers in Catterick were certainly in closer contact as a group and had more outside contacts than the children.

It may be stated that during the period June to October there were extremely few flies or other insects in the camp. The sanitation was good and intestinal diseases, apart from a very small epidemic of mild gastro-enteritis in September and October, were absent.

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REFERENCES

- Andelman, M. B., Fishbein, W. I., Casey, A. E., and Bundesen, H. N. (1946). *Sth. med. J.*, **39**, 706.
 Aycock, W. L., and Kessel, J. F. (1943). *Amer. J. med. Sci.*, **205**, 454.
 Bernstein, N. G. G., Clark, J. M. P., and Tunbridge, R. E. (1945). *British Medical Journal*, **1**, 763.
 Casey, A. E. (1942). *Science*, **95**, 359.
 — Fishbein, W. I., Abrams, I., and Bundesen, H. N. (1946). *Amer. J. Dis. Child.*, **72**, 661.
 McAlpine, D. (1945). *Lancet*, **2**, 130.
 — (1947). *British Medical Journal*, **2**, 668.
 McFarlan, A. M., Dick, G. W. A., and Seddon, N. J. (1946). *Quart. J. Med.*, n.s. **15**, 183.
 Memo by Medical Officers to Ministry of Health (1947). *British Medical Journal*, **2**, 141.
 Russell, W. Ritchie (1947). *Ibid.*, **2**, 1023.
 Warin, J. F. (1947). *Lancet*, **2**, 594.

ABERRANT ENDOMETRIAL TISSUE AND INTUSSUSCEPTION

BY

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Intussusception of the ileo-colic variety in an adult, with aberrant endometrial tissue at the apex of the entering ileum, is an unusual occurrence. V. B. Green-Armytage (1933) reports that a state of pelvic endometriosis existed in 8.9% of a series of 1,000 abdominal operation cases. Most instances in which aberrant endometrial tissue has been found to involve the peritoneal surface of the intestine are reported in locations about the sigmoid colon and recto-vaginal septum. Thierstein and Allen (1946) report 53 cases of intestinal endometriosis. Their series is subdivided into two groups: (1) 41 cases in which the endometriosis involved the rectum and recto-vaginal septum, and (2) 12 cases in which the lesions were found higher in the intestinal tract. The second group consisted of 6 cases of involvement of the sigmoid colon, 3 of caecal involvement, 1 of endometriosis of the ileum, and 2 of lesions involving the appendix.

Relatively few cases of acute or chronic intestinal obstruction due to endometriosis have been recorded. Glenn and Thornton (1940) report two cases of partial intestinal obstruction of the chronic type due to endometrial tissue. A review of the literature revealed only four cases in which the tissue involved small bowel and produced complete intestinal obstruction. I cannot find a single reported case of intussusception with endometrial tissue as a causal factor.

The justification for recording this case lies, however, not only in its extreme rarity but in the pathological histology, in which there is some evidence in support of the serosal theory of endothelial metaplasia as a factor in the origin of aberrant endometrial tissue.

Case Report

A single woman aged 23 was admitted on July 9, 1947. A year previously, while serving in the W.A.A.F., she had complained of attacks of diarrhoea and vomiting, and a diagnosis of acute food-poisoning had been made. Menstruation had started at the age of 14. The flow was moderate, lasting from

five to six days; the cycle was between 27 and 30 days. There had been severe dysmenorrhoea since the menarche, often sufficient to confine the patient to her bed, and the pain had always been associated with vomiting on the first day of the period. There was no history of pregnancy or abortion.

Three months before admission she had complained of several attacks of sharp colicky pain in the lower abdomen, more pronounced in the right iliac fossa. These attacks occurred at irregular intervals of about three weeks and lasted on each occasion for about half an hour. They had recently become more frequent and prolonged, and seemed to be clearly associated with the menstrual periods. The pain had not been relieved by sedation or antispasmodic drugs. The patient vomited during the attacks, but no nausea or vomiting occurred in the periods of intermission. The appetite was consistently poor. On two occasions there had been some diarrhoea (four or five semi-solid stools a day), but at no time was there any blood-stained discharge in the stools. The first day of the last menstrual period was 11 days before admission.

The patient was thin, lacrimose, and miserable, and was in severe pain, drawing up her legs and constantly retching and vomiting. The pulse was rapid, but regular and of good volume. The temperature was 98.6° F. (37° C.). The abdomen was uniformly tender and there was some guarding of the abdominal musculature. An oval sausage-shaped swelling was seen in the right iliac fossa. The swelling was semi-fluctuant, soft, and mobile. The white blood cells numbered 14,500 (polymorphs 80%, lymphocytes 10%).

The external genitalia were normal. The cervix and uterus were of normal size, shape, and position. A cystic swelling was palpable from the right fornix. This was distinctly felt as separate from the uterus. The mass was tender. Rectal examination confirmed the presence of a pelvic mass. Amongst the possibilities that had to be considered at this stage were appendicular abscess, Crohn's disease, pyosalpinx, extrauterine gestation, rotation of the pedicle of an ovarian tumour, and obstruction from bands or internal hernia.

Operation (July 9).—Under anaesthesia the mass felt like an appendix abscess. A McBurney incision revealed an intussusception of the ileo-colic variety, extending half-way up the ascending colon, which had to be delivered by a separate right paramedian incision. All attempts at reduction failed. A hemicolectomy was performed and an end-to-end anastomosis of the ileum to the transverse colon was carried out. Both ovaries appeared normal at operation and there was no evidence of pelvic endometriosis.

The patient made an uneventful recovery and was discharged symptom-free on July 29. On Sept. 17 she was found to be well, and the two periods since operation had passed without pain or vomiting.

Pathological Report

The specimen consisted of the resected portion of the terminal ileum, which was intussuscepted into the ascending colon (Fig. 1). The ensheathing and returning tubes had been laid open. For microscopical sections a piece was cut from the ileum at the apex of the intussusception.

Microscopical Description.—Section of the ileum (Fig. 2) showed congestion of the mucosa and submucosa and some necrosis of the mucosa. In the muscularis there were small areas of typical endometrium, composed of glands lined with tall columnar cells in an abundant stroma that was characteristic of endometrial stroma (Fig. 3), but the unusual and interesting feature in this section was that on and underneath the serosa, at the terminal tip of the intussusception and exactly opposite the intramuscular area of endometrium, there was an area showing a most unusual degree of hyperplasia of the peritoneal endothelial cells (Fig. 4). Here the cells were cuboidal, and were arranged to form branching tubules of varying size, giving the appearance of an adenoma. Proliferations of peritoneal endothelial cells, with resulting tubular and cystic peritoneal inclusions, are common in chronic pelvic inflammation, but are very rarely found to the degree shown in this section. The appearance therefore suggested the possibility that this area of peritoneal hyperplasia was an early stage in the metaplasia of peritoneal cells into "endometrial" glandular elements. Further, at a point between the endothelial tubules, areas of