

made until 48 hours after his admission; during this period he was nursed without precautions. Nurse B. C. nursed him from the day of his admission (July 21) to July 25. Three days later she had a dental extraction but was well until the 29th, when she complained of pain behind the sternum and of a slight aching pain in the left wrist. On July 31 the headache was marked: temperature 100° F. (37.8° C.); cerebrospinal fluid: 18 lymphocytes and 1 polymorph per c.mm.; protein, 30 mg. per 100 ml. Slight weakness of extensors of wrist and fingers of left hand was noted on Aug. 1.

Nothing is known of the factors that render a person susceptible to an attack of poliomyelitis. The concept that immunity to the disease is conferred in childhood by a subinfective dose of the virus is not entirely borne out by recent facts (Van Riper, 1947). Sabin (1947) has pointed out that there is evidence to suggest that there may be no relationship between an attack of the disease or the passing of an epidemic through a community and the appearance of a neutralizing antibody as tested for against a single standard strain of virus, and occasionally even against some more recently isolated strains. Burnet and Jackson (1939) have stated that poliomyelitis antibody is not a result of exposure to or infection by the virus of epidemic poliomyelitis. During the past quarter-century there has been a definite rise in the age incidence of the disease in all poliomyelitis countries. Furthermore, the disease and the mortality rate have both been more severe in adolescence and in adults than in children. Such information as is available about the recent epidemic in this country would seem to confirm this tendency. One of our cases—a doctor's wife—apparently passed the infection to her brother-in-law, aged 30, but failed to infect her own two children, with whom she was in much closer contact, despite the fact that one, aged 3, had had a dental extraction during the time she showed prodromal symptoms and the other child, aged 5, had had a tonsillectomy a few days before.

Two of our cases gave a previous history of close contact with poliomyelitis in the early febrile and paralytic stages of the disease, yet both cases remained well at that time but contracted the disease in the recent epidemic.

Case 23.—Mrs. C., aged 21. During September, 1938, when 12 years of age, she was on holiday and sharing a bed with her sister. The sister developed headache, high temperature, and general malaise, followed by severe paralysis of her right leg. A diagnosis of poliomyelitis was made. Mrs. C. continued to share her sister's bed until the latter was removed to hospital. She herself remained perfectly well, but contracted a mild attack of poliomyelitis on Sept. 2, 1947.

Case 28.—Captain R. P., aged 32. In 1945 in Washington, U.S.A., he shared a room with another man, aged 28, who developed headache, aching all over, and stiff neck, followed by paralysis of the small muscles of his right hand. He was removed to hospital as a case of acute poliomyelitis. For two days he was fed and cared for by Captain R. P., who remained well at that time but contracted polio-encephalitis on Aug. 21, 1947.

Thus it would seem that if a child or an adult is exposed to the virus and does not develop paralysis, immunity either may not occur or may be short-lived. Judging by recent reports, second attacks of the disease are not so rare as were formerly supposed. In Alves and Pugh's (1947) case eight and a half years elapsed between the attacks. The three examples recently reported by Lipscomb (1947) concerned officers in India. In one of these the second attack occurred within six months of the first. A similar short interval was recorded by Cunningham (1947). Variations in the strains and virulence of the virus may in part explain second attacks of poliomyelitis, although it is possible that unknown factors underlying susceptibility may be of equal importance.

Summary

Symptomatology in 54 cases of acute poliomyelitis is discussed—24 of the cases belonged to the non-paralytic form. There were no deaths.

Several case histories are given, including an example of a rare ocular complication (opsoclonia), as well as an unusual case of bulbar paralysis successfully treated by tracheotomy.

Attention is drawn to certain atypical features in the cerebrospinal fluid.

In nearly one-third of the proved cases contact histories suggested the probability of an abortive attack of the disease in other members of the family or in friends.

In this country the virus of acute poliomyelitis should now be regarded as the usual cause of a benign type of lymphocytic meningitis and of a brain-stem encephalitis accompanied by meningitis.

A brief reference is made to the problem of immunity.

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POLIOMYELITIS

THE PRE-PARALYTIC STAGE, AND THE EFFECT OF PHYSICAL ACTIVITY ON THE SEVERITY OF PARALYSIS

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[PRELIMINARY REPORT]

The current epidemic of poliomyelitis provides an opportunity of studying the clinical features of this disease which is fortunately seldom available in this country. Though a great variety of symptoms have been reported in the present epidemic (Kelleher, 1947) many students of other epidemics have insisted that the pre-paralytic symptoms and signs in poliomyelitis are specific, and that it is possible to diagnose the disease before paralysis develops (Kauders, 1938; Gordon, 1932; Aycok and Luther, 1928; Adamson and Dubo, 1942).

A history of great physical exertion preceding the onset of severe paralysis has often evoked comment in cases of poliomyelitis (de Rudder and Peterson, 1938; Tucker, 1941), but no attempt (so far as I am aware) has been made to investigate this aspect of the problem statistically.

It is generally agreed that a study of the pre-paralytic symptoms gives no clue to whether or not paralysis will develop. Further, the changes in the cerebrospinal fluid in the pre-paralytic stage are equally abnormal whether or not paralysis subsequently develops (Collier, 1927; Adamson and Dubo, 1942).

It is not surprising, therefore, that in recent years attention has been directed to the physiological state of the

lower motor neurone in relation to its susceptibility to the virus (Rivers, 1942).

A striking phenomenon in this connexion has been that if the anterior horn cell is engaged in regenerating its neurone—that is to say, if the peripheral nerve originating in these cells has been sectioned a few days previously—then these anterior horn cells are quite immune to experimental infection with the virus (Howe and Bodian, 1942). It is by no means impossible, therefore, that physical activity at a certain stage of the disease might alter the motor neurone physiology in such a way as to influence its vulnerability to the virus.

The present investigation aimed at analysing the early symptoms and physical activity in a group of patients convalescent from poliomyelitis who were old enough to give an accurate account of their symptoms, and at comparing the various clinical features of the disease with the degree and site of paralysis. The scheme used for recording the main facts (see Form) provides a convenient method for recording the pattern of the disease. All the cases except five occurred during 1947 in this country. To ensure uniformity all case records were made by me.

Type of Form used for Recording the Clinical Features and the Amount of Physical Activity

POLIOMYELITIS

Case No.	Hospital Seen on.....
Name	Age
Address	Handed: R/L.....
Occupation	
Prodromal illness and special features:	

Days of the Disease

Date and time:	1	2	3	4	5	6	7	>7	Ceased
	<i>Symptoms</i>								
Pain, neck									
" back									
" head									
" shoulder R/L ..									
" upper limb R/L ..									
" trunk									
" thigh R/L									
" leg R/L									
Anorexia									
Vomiting									
Fever									
Restlessness									
Sleeplessness									
Irritability									
Catarrhal									
Bulbar and other ..									
Special									

Days of the Disease

Date:	1	2	3	4	5	6	7	8	9	10	>10	Examination Date
	<i>Paralysis</i>											
Cranial nerves												
Swallowing												
Diaphragm												
Sterno-mastoid												
Neck												
Shoulder, R												
Shoulder, L												
Arm, R												
Arm, L												
Forearm and hand, R ..												
Forearm and hand, L ..												
Trunk												
Intercostals, R												
Intercostals, L												
Abdomen, upper												
Abdomen, lower												
Thigh, R												
Thigh, L												
Leg:												
Dorsiflexors, R												
Dorsiflexors, L												
Plantar flexors, R ..												
Plantar flexors, L ..												

Day of Disease	Description of Physical Activity	Score
Day minus 3 and earlier		
Day minus 2		
Day minus 1		
Day 1 (mark relation to first symptom)		
Day 2		
Day 3		
Day 4 and later ..		

With the aid of a calendar most patients were able to describe with remarkable clarity their symptoms on the days preceding paralysis. Lest the features of the disease might vary in different regions cases were seen in various parts of the country, including Oxford, London, Edinburgh, and Manchester.

Meningitic Symptoms

The so-called meningitic symptoms in the pre-paralytic stage are of special importance, for it is only by the study of these that one can hope to diagnose poliomyelitis before paralysis develops. These symptoms may, however, present in widely differing ways, and they vary greatly in severity. At first the meningitic symptoms may be slight and appear to the patient to precede the real onset of the disease. Again, severe pains may occur, say, in the thighs for a few hours only, and may be followed by a period of perhaps 24 hours in which he feels quite well.

For the purpose of the present analysis meningitic symptoms were taken to include all those which caused pain in the head, spine, trunk, or thighs; a general feeling of aching all over was not included.

There is no doubt that in some cases the patient feels unwell before the meningitic symptoms develop; but, as the meningitic symptoms are so important for diagnosis, in this study Day 1 of the disease is taken as the day on which the first meningitic symptoms appear. In Table I the relation between the onset of meningitic symptoms at ↑ and the appearance of paralysis at P is clearly shown. It is evident that in the majority of cases the meningitic symptoms precede paralysis by three or more days. The detailed analysis and correlation of symptoms, site of paralysis, etc., must wait for a later study.

The so-called meningitic symptoms often suggest nerve-root irritation and may indicate that the virus travelling up the peripheral nerves has reached the vicinity of the meninges. Experimentally, the virus travels up the peripheral nerve at 2 to 3 mm. per hour (Howe and Bodian, 1942), and does not reach the spinal cord until the day preceding paralysis (Bodian and Cumberland, 1947). Another misleading feature of the pre-paralytic stage is that prior to the onset of paralysis the patient's symptoms often become less severe; he feels better, and may think that his illness is passing.

Meningitic symptoms appeared in the pre-paralytic stage in all but one case (No. 22) of this series. The initial site of meningitic pain was as follows: back of the neck, or subjective neck stiffness, 11 cases; dorsal spine or scapular region, 5 cases; lumbar spine, 5 cases; sacral spine, 4 cases; chest (bilateral), 6 cases; one or both thighs, 2 cases; head (frontal or general), 10 cases. In most cases two, three, or more of these symptoms developed during the pre-paralytic

TABLE I.—Record of physical activity in the pre-paralytic stages in 44 cases of poliomyelitis. The † in Day 1 indicates the onset of the first meningitic symptom, and P gives the onset of paralysis. The footnote gives the method used for scoring the amount of physical activity and the severity of paralysis.

No.	Sex	Age	Day -2	Day -1	Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7		Degree of Paralysis
					a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	
1	F	33	+	+	++	†	±				bed		bed		P			Paralysis became worse on Day 9	Moderate
2	F	17	+	+	†	†	++				bed P		bed						Severe
3	M	25	++	++	†	†	++				bed P		bed						Moderate
4	M	14	+	++	†	†	±				bed P								Slight
5	F	14	+	++	†	†	bed			P									Very severe
6	M	37	++	++	†	†	++			+			bed P						Severe
7	F	11	+	+	†	†	bed			+			bed P						Slight
8	M	20	++	++	†	†	bed			bed			bed P						Severe
9	M	19	++	++	†	†	++	P		bed			Respirator						Slight
10	M	43	+	+	†	†	bed			bed			bed P						Very severe
11	M	12	+	?	†	†	bed			bed			bed P			P			Slight
12	M	18	?	?	†	†	bed			bed			bed P						Moderate
13	M	16	++	++	†	†	bed			bed			bed P						"
14	F	31	+	+	†	†	bed			bed			bed			P			Slight
15	F	10	±	bed	†	bed	bed			bed			bed						"
16	F	14	+	+	†	†	bed			bed			bed						Severe
17	F	32	+	+	†	bed	bed			bed			bed			bed			Nil
18	M	20	+	+	†	†	bed			bed			bed P						Severe
19	M	10	+	+	†	†	bed			bed			bed P						Slight
20	M	17	+	+	†	†	bed			bed			bed P						"
21	F	20	+	+	†	†	bed			bed			bed						"
22	M	21	+	+	†	†	bed			bed			bed						"
No meningitic symptoms in this case—excluded from Tables I and II																			
23	M	10	+	++	†	†	bed			bed			bed P						"
24	F	14	+	++	†	†	P			bed			bed						Moderate
25	F	30	+	+	†	†	bed			bed			bed			P			Slight
26	F	9	+	+	†	†	bed			P			bed						"
27	F	11	+	+	†	†	±			bed P									"
28	F	12	+	+	†	†	bed			bed P									"
29	F	21	++	++	†	†	±			bed			Respirator						Very severe
30	F	8	+	+	†	†	bed			bed			bed P						Slight
31	F	22	+	+	†	†	±			P			Respirator						Very severe
32	F	20	+	+	†	†	±			Respirator			bed						"
33	F	32	++	+	†	†	++			bed P			P						Slight
34	F	21	++	++	†	†	bed			bed			P						"
35	M	16	++	++	†	†	±			±			++						Severe
36	M	42	++	++	†	†	++			++			++						Very severe
37	M	20	++	++	†	†	±			+									"
38	M	20	++	++	†	†	±			±									"
39	M	19	++	+	†	†	P			±			P						"
40	F	33	++	+	†	†	bed			bed			Meningitic symptoms slight and late						"
41	F	28	±	±	†	†	bed			bed			P						Slight
42	F	8	+	+	†	†	bed			bed			bed						Nil
43	F	8	+	+	†	†	bed			bed			bed						"
44	M	16	++	++	†	†	++			++			bed						Very severe

Physical activity scores for each 24-hour period.—Nil = In bed. ± = Not more than 1/4 day light work—e.g., resting in house with a short walk. + = Average light work—e.g., secretarial, housework, school. ++ = Average or heavy manual work, factory or labourer or school with football or other athletic sports. (In Table III where physical activity for a period of more than 24 hours is recorded the scores for the days concerned are added together.)
Paralysis Grading.—Nil: no paralysis even temporary. Slight: no severe paralysis anywhere at any time—full recovery expected. Moderate: multiple moderate paralysis or severe paralysis of a few muscles in one limb. Severe: bilateral severe paralysis at any level including trunk, or gross paralysis of one limb. Very severe: severe and extensive paralysis such as trunk and both lower limbs or severe paralysis of all four limbs.

stage. For example, in the cases which presented with head pain, other symptoms developed as follows:

- Case 6: 24 hours later, pain in both thighs.
- " 13: 12 " " neck stiffness.
- " 16: 48 " " neck and shoulder pain.
- " 17: 24 " " neck stiffness.
- " 27: 48 " " lumbar pain.
- " 28: 12 " " neck and back pain.
- " 35: 12 " " neck pain.
- " 39: No other symptom noticed till paralysis developed.
- " 42: 24 hours later, neck pain and stiffness.
- " 43: " " " neck stiffness.

The cases which presented with chest pain developed other symptoms rather late:

- Case 10: 72 hours later, pain in back.
- " 18: " " " lumbar pain.
- " 21: 48 " " sacral pain.
- " 34: 24 " " headache and, 12 hours later, sacral pain.
- " 41: 4 days later, lumbar pain.
- " 44: 3 " " headache.

The chest pain reported in six cases is of special interest as its characteristics resemble closely the chest pain of epidemic myalgia (Bornholm disease). This pain is usually bilateral and referred to the lower half of the thorax; it is aggravated by a deep breath and often associated with, and indeed may consist chiefly in, a hyperaesthesia with tenderness on pressure over the lower chest.

It is clear, therefore, that though a variety of initial symptoms may be observed, the vast majority of cases

show meningitic symptoms by the time they are seen by their doctor—say within 24 or 36 hours of the onset of the pre-paralytic stage. I have not observed in this series the signs on examination at this stage, but it may be emphasized that neck and spinal rigidity are the most important signs. There may also be slight jerky movements of the limbs or eyes, while examination of the cerebrospinal fluid is of great value in confirming the diagnosis. A misleading feature may be that the patient both looks and feels well, and may have little or no fever. For example, a patient with severe neck pain when seen at a hospital out-patient department was told to return next day for an x-ray examination of his neck: 24 hours later he developed extensive paralysis. Another example is that of a young woman who, owing to severe lumbar pain, was thought to have kidney disease: within 12 hours she was almost totally paralysed, and was kept alive by a respirator. A remarkable feature of many of these cases is that when the initial symptoms have developed the patients do not feel ill. It is clear, however, that when the patient is old enough to describe his symptoms an analysis of these, combined with signs due to rigidity of the spine, gives a fairly specific clinical picture in most cases of poliomyelitis. These cases then require only examination of the cerebrospinal fluid for confirmation and in order that meningitis may be excluded.

Physical Activity and Paralysis

In the course of this study it soon became apparent that the patient's activity during the pre-paralytic phase varied to a remarkable degree. This seemed to be due to the fact

that the early "meningitic" symptoms are often of insufficient severity to force the patient to go to bed or indeed even to modify his routine work. It is clearly desirable that the information available regarding the degree of physical activity should be correlated with the severity of paralysis in such a way that the figures can be handled statistically.

Tables II and III relate the degree of paralysis to the amount of physical activity during the 24 and 48 hours following the onset. I am greatly indebted to Dr. R. B. Fisher for the further analysis of this material.

Statistical Analysis

The number of cases in this survey is too small to warrant a detailed analysis, so that attention is best directed to broad classifications and practical conclusions. The paralysis gradings have therefore been grouped into the two classes of (a) patients in whom full recovery is likely (*nil* and *slight*), and (b) those in whom some residual impairment is likely (*moderate*, *severe*, and *very severe*).

Using these broad classifications, it was first shown that the history of exercise before the onset of meningitic symptoms has little bearing on the prognosis. Four patients are excluded from this analysis—two because of the vagueness of the history of meningitic symptoms (Nos. 22 and 39), one because of doubt concerning the degree of activity before meningitic symptoms (No. 12), and one because the short interval between meningitic symptoms and paralysis precluded inclusion in the later stages of the analysis (No. 24).

All the remaining 40 patients were up and about on the day before meningitic symptoms appeared, and all but three were engaged in their ordinary activities. Separating them into lighter (\pm and $+$) and heavier exercise ($++$), we get the following association between exercise in the day preceding meningitic symptoms and severity of the disease:

	Lighter Exercise	Heavier Exercise
Full recovery expected	16	4
Residual impairment expected	11	9

Although the proportion more severely affected is greater in the heavier exercise group, there is such a high probability (0.1–0.2) of obtaining as great (or greater) a difference by chance in sampling from a population in which there was no association between exercise and prognosis that we may say there is no significant effect of exercise, in this time period, on prognosis.

If, however, we examine the effect of exercise after the appearance of meningitic symptoms the findings are very different. Bringing in Case 12, which can no longer be validly excluded, and dividing the patients into those in bed and those indulging in any degree of normal activity, we have for the first 24 hours after the onset of meningitic symptoms:

	Rest	Exercise
Full recovery expected	10	10
Residual impairment expected	1	20

The probability of getting such an extreme distribution by chance is less than 1 in 800, so that one can be confident that complete rest in bed in this period has a profound effect on prognosis. All patients taking to bed at this time remained there for the course of the illness, so that the effect observed is of exercise starting in the 24 hours succeeding the onset of the meningitic symptoms.

The data provide one more answer of direct importance. If we exclude the 11 patients who were in bed in the first 24 hours after meningitic symptoms, and examine the effect of rest starting in the second 24 hours, we have the distribution:

	Rest	Exercise
Full recovery expected	8	2
Residual impairment expected	2	18

and the chance of obtaining so extreme a distribution by chance is a little less than 1 in 3,000.

Thus over all we find, differentiating from the remainder those patients in whom rest in bed is instituted in either the first or the second 24 hours after the onset of meningitic symptoms, the distribution of cases by prognosis to be as follows:

	Rest	Exercise
Full recovery expected	18	2
Residual impairment expected	3	19

This distribution is even more striking than in the preceding two sets of figures; and, in fact, the figures understate the influence of exercise, since two of the cases in the lower left quadrant of the table fall into the "moderate" classification of paralysis, whereas all but one of the 15 cases in the "severe" and "very severe" categories of paralysis fall in the lower right quadrant.

These data, therefore, show quite unequivocally that, irrespective of exercise before the appearance of meningitic symptoms, institution of rest in bed as early as possible after these symptoms have appeared has a profound effect on the course of the disease.

It is difficult from analysis of this material to evade the conclusion that *physical activity in the pre-paralytic stage of the disease gravely reduces the resistance of the spinal cord cells to the virus and should therefore be avoided at all costs.*

Excessive physical activity has for long been suspected as an aggravating factor, but the present study suggests that relatively minor degrees of physical activity are also dangerous. The psychological study of those who develop severe paralysis would be of interest, for it has been said that during an epidemic the disease affects "the best child in a family," who may also be the most courageous or stoical and continues physical activity without complaint after the first meningeal symptoms have developed. Certainly the severe cases of paralysis in the present series furnish many tragic records of courage and determination to continue work or play after symptoms began. The worst cases in this series are all those which required an artificial respirator owing to respiratory paralysis. The persistence in normal activity after the first meningitic symptom is a striking feature of every one of these cases.

Case 9.—A paratrooper aged 19. *Day 1:* From 11 p.m. the previous evening to 2 a.m. there was severe lumbar pain which kept him awake; he kept moving restlessly to change his position. On getting up in the morning he felt shivery and had little appetite. Heavy training manoeuvres as usual during the day. Slept well that night—no return of lumbar pain was noticed. *Day 2:* He does not remember pain, but had some difficulty in getting down to fasten his boots in the morning. He still had little appetite and felt shivery. During the morning he took part in heavy infantry manoeuvres and carried machine-guns up a hill. By 2.30 p.m. his legs began to feel weak and he noticed lumbar pain. By evening both lower limbs and right arm were completely paralysed. *Day 3:* The paralysis spread to his trunk muscles; there was some vomiting. *Day 4:* Respiration failed—respirator required. Six weeks later he was still in the respirator and there was little recovery in his muscles.

Case 29.—A female factory-worker aged 21. *Day 1:* Wakened with pain in the neck, back, and head. She worked all day in the factory, and the journey to work involved travelling for an hour each way. She vomited and noticed something peculiar about her eyes: she thought she might be getting infantile paralysis. *Day 2:* After sleeping well she still had pain in the neck, back, and head. She got up and walked (15 minutes) to see her doctor, who told her she had a chill, so she returned home, went to bed, and took castor oil. *Day 3:* The pains were less severe. She remained in bed and felt rather better. In the evening some friends called and she sat up in bed talking to them for four hours (6 to 10 p.m.). Within an hour of her friends' leaving she noticed weakness of her limbs. *Day 4:* By early morning she was totally paralysed, her respirations were failing, and when she reached hospital she was severely cyanosed and was at once placed in a respirator. Ten weeks later there was very little recovery, and she was still unable to breathe without the respirator.

Case 31.—Female aged 22; taken ill overseas while serving in the W.R.N.S. in 1944. *Day 1:* Wakened with a very severe sacral pain which spread into both thighs—the worst pain she has ever experienced. Otherwise she felt fairly well and worked all day at the office. While at work the pain was so severe that she could not refrain from groaning. In the evening the pain

was still severe, but she went out to a dinner party. She returned to her billet at 10 p.m., but the pain was of such a nature that she could not lie down in comfort, so she sat at a table all night, getting up to walk about from time to time to ease the pain. *Day 2*: She reported sick after this sleepless night, and was sent to hospital. She was able to walk to the ambulance, and to put herself to bed in hospital. During the afternoon and evening she developed complete paralysis of her lower limbs and trunk; she was put in a respirator, which was required for five weeks. Three years later there was no recovery in the lower limbs or trunk; the upper limbs were normal.

Case 32.—A female aged 20; taken ill shortly after arriving in Egypt. *Day 1*: Wakened with severe pain in both scapular regions. Spent the day shopping and looking round Cairo. *Day 2*: After sleeping well the severe shoulder pain was still present and headache developed. She continued her normal activities and enjoyed a large lunch. During the morning she ate a large number of fresh dates. She rested in the afternoon, as her pain and headache were very severe, but at night she helped to entertain friends to dinner and games. She was able to eat a good dinner, but her pain and headache were severe and it was a "frightful strain" to appear well to her guests. She vomited that evening, but was able to sleep. *Day 3*: She remained in bed but was very restless. Severe pain in her back developed and her temperature was raised. She slept well that night. *Day 4*: The pain was not quite so severe, and she was able to walk to the ambulance which took her to hospital. During the afternoon complete paralysis quickly developed in all limbs and trunk, her respiratory muscles failed, and by evening she was put in a respirator. A year later very little recovery had occurred, and the respirator was still required at night to enable her to sleep.

Case 38.—A mechanic aged 20; taken ill in August, 1946. He subsequently said that he would ignore a pain unless it was severe. He had been training for football every evening after his day's work. *Day 1*: While coming off the football field he caught his back while going under an iron bar. This minor injury "hurt him much more than it should"—so much so that after training for a further five minutes he went home. The back pain continued, but otherwise he felt well and had a good night. *Day 2*: The pain and back stiffness continued. He tried to get out his motor-cycle to go to work, but found it too heavy, so stayed at home. In the evening he walked (five minutes) to see his doctor. He slept well that night. *Day 3*: He was so stiff that he could not bend to tie his shoes, but he again walked to see his doctor in the morning, and then lay on his bed for most of the day. *Day 4*: The pains were worse, and were now very severe in his neck and had spread to all his limbs. His appetite was poor and he vomited. During this day severe paralysis developed quickly in all his limbs and trunk. He did not feel very ill, and was propped up in bed at home. *Day 5*: He developed difficulty in swallowing, retention of urine, and some vomiting. *Day 6*: His headache and pains ceased, but breathing was difficult. *Day 9*: He was put in a respirator, where he remained for six weeks. Fourteen months later there was still severe paralysis of all four limbs and trunk.

Case 40.—A housewife aged 33. The day before the first meningeal symptom she did a heavy day's work. *Day 1*: Normal housework, but by evening noticed a dull ache in her back which made her want to bend backwards. There was also pain in the head and thighs. It was difficult to get comfortable in bed, but she got relief from a pillow under the small of her back and slept well. *Day 2*: She awoke with severe pain in the back and scapular region, and less severe pain in both thighs. She felt stiff and could only move slowly. She debated with herself whether to leave her husband and family to get their own meals, but thought it "a bit mean" and struggled on. She hates "to be beaten by anything." She therefore fed her baby and cooked the meals, but this was a great struggle, and she sat about the house restlessly trying to find ease for her back, and trying one chair after another. During the day she took about 12 tablets of codeine co., which helped her headache but gave little relief to the pains in her back and limbs. That night she got little sleep and restlessly changed her position in an attempt to get relief. *Day 3*: Her back and limbs were less painful, but she had no desire to

eat and felt feverish. She remained in bed most of the day, sleepless and restless. During the evening her thighs and trunk felt a little weak. That night she was again restless and sleepless. *Day 4*: After a bad night she called in her doctor for the first time. She was now aching all over, with high fever and vomiting, but the pain in the back was much less and occurred only on movement. During the day there developed severe paralysis of the trunk and lower limbs. On the sixth day the paralysis rapidly spread to the upper limbs. She was admitted to hospital on the seventh day and had to be put in a respirator at once, as her breathing had failed.

Case 44: A schoolboy aged 16. *Day 1*: Developed a feeling of constriction in his chest, which he felt specially on taking a deep breath. He also had slight pain in the right groin. He attended school, and in the evening he ran in a 100-yards race. *Day 2*: Symptoms unchanged, but in the evening he had a stiff feeling on bending. He felt well, sat examinations, and played a hard rackets match, losing 3 games to 1. *Day 3*: Symptoms continued, and for the first time he felt "seedy." After school he ran a half-mile race, and did not do as well as he expected. *Day 4*: The symptoms continued, but after lunch he developed a severe headache. He played tennis for half an hour, and that evening reported sick for the first time. He was put to bed, sleepless and restless. During the night severe paralysis developed in his trunk and lower limbs, and his arms also became weak. He kept moving his legs till they would move no longer, and developed retention of urine. On the ninth day his breathing became difficult and he was put in a respirator for three days. Four months later there was still gross paralysis of his trunk and thighs. The upper limbs were recovering well.

Therapeutic Applications

These case records make distressing reading in view of the evidence afforded by this study that physical activity is dangerous in the pre-paralytic stage. The danger of physical activity throws an extra responsibility on the practitioner regarding the need for early diagnosis. It is particularly important that he should be familiar with the possible ways in which the disease may present, so that strict rest can be enforced in all cases of doubt. Further, it is clear that restlessness in bed, pain, and resulting muscle spasm should be controlled, but I am not yet in a position to advise on the best drugs to use for this purpose. The need for complete rest in bed is very evident and the patient should lie quietly, moving or using his limbs as little as possible.

It should be emphasized that these records indicate not only that severe exercise in the pre-paralytic phase is highly dangerous, but that physical activity of any kind may be harmful. Tables II and III show that *none* of the patients

TABLE II.—Physical Activity During 24 Hours Following First Meningeal Symptom

Severity of Paralysis	Nil	Slight ±	Moderate +	Severe ++
None	3	—	—	—
Slight	7	5	3	2
Moderate	2	1	3	1
Severe	—	—	5	1
Very severe .. .	—	1	4	5

TABLE III.—Physical Activity During 48 Hours Following First Meningeal Symptom

Severity of Paralysis	Nil	±	+	+±	++	+++	++++
None	2	1	—	—	—	—	—
Slight	6	5	3	—	3	—	—
Moderate	2	—	2	1	1	—	1
Severe	—	—	1	1	2	1	1
Very severe .. .	—	1	—	2	2	2	3

who stayed in bed after the onset of symptoms developed severe paralysis, and that *all* those who indulged in much physical activity for the two days following the first

meningeal symptom developed paralysis which was usually very severe. (Case 22 was excluded from these tables.)

Summary

Forty-four patients convalescent from poliomyelitis, who were old enough to describe their symptoms, were questioned at length regarding their early symptoms and also the amount of physical activity during the early days of the disease.

The so-called meningitic symptoms appear in nearly all cases during the pre-paralytic stage of the disease and are of great value in diagnosis. These symptoms are often more suggestive of involvement of nerve roots than of meninges. They consist of pain in the head, neck, dorsal, lumbar, or sacral spine, scapular region, thighs, or the lower chest.

The meningitic symptoms may be slight or severe. At their onset the patient may be afebrile and may feel quite well.

The meningitic symptoms may abate and the patient feel better shortly before paralysis develops.

Physical activity of any kind during the pre-paralytic stage increases the danger of severe paralysis.

Complete physical rest in bed during the whole of the pre-paralytic stage seems to protect the patient from severe paralysis.

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NOTE.—Case records giving the details required for this study will be welcomed for further analysis.

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POLIOMYELITIS AND POLIO-ENCEPHALITIS

THE CASE FOR A REVIEW OF TERMINOLOGY

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From studies of clinical reports on cases notified as poliomyelitis and polio-encephalitis during the present epidemic it is evident that value can be obtained from a review of the varied manifestations of this disease, and an attempt made to correlate them into a reasonable clinical classification. As a result of this review certain recommendations are put forward.

Illness of Infection.—The existence of a true illness of infection is now accepted. This usually takes the form of mild fever and headache, with or without a nasopharyngitis, lasting one to two days, or of gastro-enteritis. Its onset probably occurs one to four days after the infection. Cases have been described in which the patients suffer from this initial illness but do not subsequently develop paralysis. Such cases are recognizable only among contacts of poliomyelitis during the course of an epidemic or unusual pre-

valence. It is impossible, in the state of our present knowledge, to estimate the proportion of persons who have an illness of infection, but it may well be very large, and it is unknown as yet whether they assist in the spread of the disease as temporary carriers; such a possibility, however, must be entertained.

Incubation Period of Recognizable Poliomyelitis.—This is normally seven to 14 days, but there are outside limits of two days to 25 days, although it has been recorded that the virus was discovered in the stool of a person who developed clinical signs 19 days later. A few cases are on record of patients suffering vague signs and symptoms, persisting throughout the whole of the incubation period from the illness of infection—tingling in a muscle or muscle group, restlessness at night, listlessness, or vague signs of being off colour (Gartside, 1947).

Proposed Classification.—The subsequent progress of the disease may follow different courses. Clinically each case may be put into one of the following two categories: (1) non-paralytic poliomyelitis—(a) subclinical and (b) clinical; (2) paralytic poliomyelitis—(a) spinal, (b) bulbar, and (c) bulbo-spinal. In this classification—a clinical one—it will be noted that the term “abortive” has not been included in the types of disease. It is thought better to discontinue the use of this term, as “abortive” encourages a wrong concept of the disease. What have been called abortive cases—like the subclinical cases (see below)—are true infections with the poliomyelitis virus, and as such, particularly when it is appreciated that these two types form by far the greatest number of cases in an epidemic, have an equal if not more important role in the spread of the disease than the paralysed case, whose activities are necessarily restricted by virtue of the illness. Abortive cases should be termed “non-paralytic poliomyelitis,” as there is no difference in the initial symptoms and signs of this type and those cases which go on to paralysis.

Non-paralytic Poliomyelitis

Subclinical Poliomyelitis

In 1945 a team of workers in Chicago made a detailed study of 22 children after a known exposure to a case of poliomyelitis (Casey, 1946); 14 had a febrile illness between seven and 25 days after exposure. No comparable illness occurred in a group of 15 children, not so exposed, who lived near by. Among the 14 children who developed fever one had frank poliomyelitis; two had frank poliomyelitis without paralysis but with stiff neck, stiff back, head-drop, and increased cells and protein in the cerebrospinal fluid; four had fever and mild symptoms without stiffness in back or neck, or paralysis, but two of these gave a cerebrospinal-fluid protein above 45 mg. The other seven children (the subclinical group) had axillary temperatures between 98.8° and 99.8° F. (37.1° and 37.7° C.), but seemed to have no symptoms; four of these, on lumbar puncture, gave protein figures of 45 mg. or more. Stool examinations revealed the presence of the virus just before or at the onset of the symptoms among most of the contacts with fever.

Though the figures are small, and further investigation is necessary, it does seem to indicate that poliomyelitis, during an increased incidence of the disease, is a mild, widespread, highly communicable disease particularly of young children, leaving no paralysis. It is impossible to state just how widespread is the dispersion of the virus, but it can with confidence be said that it is very considerable.

Clinical Poliomyelitis

It is felt that undue stress has been laid on the term “prodromal stage” or prodromal signs and symptoms, with the tendency to regard those cases which do not progress