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A STUDY OF A CASE OF FAMILY PERIODIC PARALYSIS.¹BY JOHN K. MITCHELL, M.D.,
OF PHILADELPHIA.

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THE curious condition of periodic paralysis is one of the utmost rarity, and in this country but three cases have been seen, with a doubtful fourth, previous to the ones herein reported. I should omit from the consideration the cases of Rich, where the paralysis was directly due to a hereditary susceptibility to cold, and was distinctly spasmodic in character. Gibney's cases, supposed by him malarial in origin, certainly do not belong to this group either.

I do not propose to enter into the history of the previous study of this disorder except incidentally. An admirable paper by Dr. E. W. Taylor, in the *Journal of Nervous and Mental Disease* for September and October, 1898, contains a very complete bibliography of the previous work, with analyses of all the cases hitherto reported, and to this I am not able to add anything except my own cases.

All the cases observed have presented, with small variations, the same type—a paralysis of the voluntary muscles, usually total except for the head and face muscles, with loss of reflexes, with absence of electrical reaction, with no mental or sensory disturbance, and occurring periodically at somewhat regular intervals. Nearly all of the cases have instances in the parents or ancestors of the patient. In the family of my patient the first one known to have suffered from it was the maternal grandfather of the present victim, a Pennsylvanian by birth, a tinsmith by trade, who had in early life seizures like those from which my patient has suffered, but much less severe. A first cousin of this same grandfather had periodic attacks of paralysis quite as bad as any which have been described. His business kept him travelling much through the rough mountain districts of central Pennsylvania, and he used to say that he was often obliged to get off his horse and "have a paralysis." Both these persons, so far as known to their descendants, ceased to have the attacks in middle life.

The mother of the patient is one of six children. Of three elder sisters none have ever had any spells of the palsy. An older brother had one attack, brought on by overexertion, but has never had another.

¹ Read before the Association of American Physicians, May, 1899.

A younger brother has suffered in the same way, but the attacks did not begin with him until he was a grown man, and have since occurred only at long intervals. A daughter of this brother, now between twelve and thirteen years of age, has periodic palsies of the same sort, and full details of these two cases follow my patient's history. None of the other cousins except this one has ever had the family affliction. The mother of the patient began to have periodic paralyses when fourteen years of age, probably at about the time when her menstruation appeared. Their approach was sometimes announced by a slight sense of helplessness, which would last for a whole day. Going to bed with this, she would wake in the morning with total muscular paralysis, usually lasting thirty-six hours, seldom longer, and never more than forty-eight. The paroxysms recurred at long and rather irregular intervals, often months apart, and after she reached adult life decreased in frequency with the advance of years, and ceased altogether at about the thirty-eighth year. She is now forty-four years of age, and presents some interesting symptoms.

Mrs. E. J. is a well-looking woman, scarcely appearing as old as she is, calls herself perfectly well, menstruates regularly, and is active mentally and physically. She has a little difficulty in walking unless the ground is perfectly smooth; a very slight inequality makes her stumble, and if she stumbles she is very apt to fall. This is especially marked at night, when she cannot see where she is going, and has been noticed for some years. When sitting she gets up with some difficulty, rising as if her legs were weak, with a sort of wiggle, and aiding herself with the nearest object upon which she can lean. She thinks this is rather worse of late years, but she had not thought it bad enough to mention until her attention was called to it by questions. Her station is perfectly good, her pupillary reactions normal; the knee-jerk decidedly slow and small, a little better on the left than on the right; on the right there is no ankle-jerk, on the left the ankle-jerk is present. There is muscle-jerk in both arms and in the left leg, but none in the right leg. Galvanic and faradic reactions are normal, and there is no alteration in sensibility. The state of things presents a somewhat mixed character, which were it not for its very long duration, the absence of eye-symptoms and of pains one might incline to think preataxic; but if it were of tabetic nature it would be symmetrical and would not present entirely different qualities of knee-jerk upon the two sides, as it does, in these respects resembling rather the ataxic paraplegia of Gowers than true tabes. Her gait shows no abnormality whatever, but I incline to the belief that the repeated attacks of her earlier life have in some way definitely altered the lower segments of the spinal cord and impaired the control of the legs. There is no trouble with the functions of the bladder, rectum, or uterus.

The present patient, C. H. J., nineteen years of age, is a mechanic in a bicycle factory. But for the neurosis under consideration no hereditary disease is known on either side of his family. His mother's history has been given; his father is living and in excellent health; his younger brothers and sisters are well, although it may be said they have not yet reached the age at which the palsies usually appear. With the exception of the ordinary diseases of childhood his own health has been perfect, his habits good, and his life an active and wholesome one until his present trouble began, in his thirteenth year.

The onset was sudden, without known cause. He awoke one morning and found that he could not move hand or foot; he was able to turn his head from side to side, but could not raise it from the pillow. There was no pain, no loss of sensation, no impairment of function of any kind. About two months after the first attack another occurred, and for three or four years they returned at intervals of about two months, with a duration generally of forty-eight hours, nearly always coming on during the night, so that the patient went to bed feeling no more than a trifling degree of enfeeblement in the legs, and awoke in the morning quite helpless. No possible cause can be assigned in his habits or mode of life. He cannot trace any single attack to excessive exercise, emotion, or indulgence of any description, and except that when they pass he finds himself a little sore and stiff for a few hours; he cannot see that he is otherwise than perfectly well in the intervals.

The intensity of the attack has remained about the same up to the present, but for nearly a year past the frequency of occurrence has become rather greater, and for six months before he was first seen, in October, 1898, the paralyzes had recurred with remarkable regularity upon Wednesday of every week.

It is well to say at once that nothing about the patient between or during the attacks suggests the slightest possibility of a hysterical element. He is a normal, healthy boy, well developed, in admirable physical condition, and much disgusted with the enforced idleness of this disablement. Many attacks have been seen in the hospital, and the various seizures differ only in the degree of immobility produced. One may be described in detail and stand for a type. Sometimes for a few hours in the afternoon or evening the patient notices slight weakness in the lower limbs, and if examined at this time at least one decided symptom is present—a lessening of the knee-jerk. This happened to be the case when I showed him one evening at the Philadelphia Neurological Society, when he said, after coming into the room: "I am just beginning to feel an attack coming on," and upon examination the knee-jerks were found to be capricious, diminished, and easily exhausted. This prodromal period is not always present. He may go to bed perfectly

well and awake in the morning wholly paralyzed from the neck down. I say "from the neck down," but the neck to a certain extent shares in the difficulty. He can, when lying still, turn the head from side to side, but he cannot raise it from the pillow, and if placed in an erect position the head falls forward on the chest, or backward almost between the shoulders, without the possibility of any control on the patient's part.

Breathing in the attacks is somewhat shallow, and appears almost altogether diaphragmatic in character. If he is requested to cough he is unable to, or even to take a normally full inspiration. If the nares are irritated he cannot sneeze, though he feels the annoyance and has a desire to do so.

He does not have much appetite, and says he perceives slight difficulty in swallowing, but this is not evident to the observer. While the paralysis lasts he usually passes water only once or twice in the twenty-four hours and has no fecal movement. There is no disturbance of the mind; speech is not affected, and he has no pain except the discomfort of lying absolutely in one position, which somewhat annoys him. So far for his own statement of his feelings and symptoms.

PHYSICAL EXAMINATION DURING AN ATTACK. The patient is notably paler in the attack than during healthy intervals. His lips are less well colored; his tongue is somewhat coated and his breath has a heavy smell, but there is no change of expression and certainly no mental impairment. He answers readily to all questions and takes an interest in the examination of his symptoms.

Upon study of the chest the breath sounds are found to show slight general lessening, due, probably, to imperfect dilatation of the chest. On being asked to take a long breath he makes an effort to do it, but has little control of the accessory muscles, and moves the cage of the ribs but slightly. The heart's action and pulse are decidedly changed from normal. The apex-beat is below the fifth rib, rather indistinct, two and a quarter inches from the mid-sternal line. The heart's action varies much in different attacks; it is sometimes a little irregular in time, though no distinct intermittency has been observed at any time. The heart conditions, however, were not always the same during the attacks. Examined several times during October and November in attacks, the heart presented usually a split second sound, very distinct in the pulmonary area, a systolic murmur well heard upon full expiration and limited to the same area, transmitted somewhat up and down the left side of the sternum, strong and decided, but not loud or harsh.

In the latter part of November, examining him one day with Dr. Morris J. Lewis, we both agreed that there was a soft, low, systolic murmur, best heard at full expiration at the second right interspace and very faintly upon the left side. This was a condition which was never found again. Three days later, during an interval, the split

second sound was heard at the second interspace, diminishing toward the apex, with a murmur much harsher than before and of greater intensity. The most careful examination with stethoscope and phonendoscope fails to reveal any increase in the area covered by the heart dulness. The pulse is somewhat weak and small, from 80 to 90 during an attack; sometimes, with about the same speed, its tension is increased and its character distinctly dicrotic, as shown in sphygmographic tracings made repeatedly during the attacks.

The heart examinations were made over and over again. I made not less than a hundred careful examinations of the heart in the attacks, and as he was an object of interest to the other members of the hospital staff, the examinations were made many times over by them, and the general opinion confirmed the above statements, which indicate rather a relaxed condition of the heart muscle, as well as of the whole arterial system, than an acute cardiac dilatation. In this belief I am supported by the high authority of Professor J. M. Da Costa, who studied the heart during an attack.

The reflexes in the more severe paroxysms are totally lost except the reaction of the pupil. No contraction can be observed in the pectoral muscles on striking them; the abdominal recti do not contract to ordinary stimuli, the cremasteric reflex is abolished, there are no knee-jerks, and although the patient resents the attempt to secure the plantar reflex by irritation of the sole of the foot, no muscular contraction takes place. Sensation is perfect. The electrical examination was many times repeated during the attacks and in the intervals. In the typical attack there was practically total abolition of reaction to any form of electrical stimulation.

In milder attacks some variations upon these general symptoms were noted. Muscle-jerks were sometimes present, the knee-jerks were occasionally found present by reinforcement, the cremasteric reflex was at times not altogether absent, though usually weakened. In the same way the degree of muscular enfeeblement varied a little. In the early part of even severe attacks, during the morning hours, the patient would be able to move his hands, perhaps his forearms, or even his toes. As the day went on the paralysis would become deeper and all movement would be abolished. Return of normal conditions followed much the same order that characterized the onset. The knee-jerks improved a little, other reflexes reappeared, slight contractility in the muscles was discoverable, and in the course of an hour or so from the beginning of betterment the patient was almost perfectly well. Several times periods of apparent partial recovery were followed by relapses into total paralysis. Usually progress was steady and rapid, and several times we have seen a man who at six o'clock was, so far as power to move or to respond to electrical stimulation could tell, as dead as a twelve-hours'

corpse, able to walk about the ward at seven o'clock with all his muscular power, his reactions and reflexes, in normal condition.

Once at least in the course of the several months the patient was under observation he seemed to have a kind of abortive attack, in which during some days he felt dull and had the same sense of lack of complete muscular power which usually precedes a paroxysm. At the same time his color was poor and his appetite not so good as usual. Knee-jerks during the whole of this period were found to be occasionally absent, though reinforcible, and at other times capriciously present, but always diminished. It should be added that this was during a time when he was taking bromide in moderate doses. One important fact developed somewhat late in the case, or at least had not been previously observed. Upon my remarking that I should give him injections of Brown-Séquard's elixir, and that it might have an effect in stimulating the sexual functions, he laughed and begged not to have it, because he said there was sufficient stimulation in the attacks already, and that very often he suffered with partial or complete erection during the period of paralysis.

[Copy of letter from the patient's maternal uncle, Mr. C. H. W., dated January 29, 1899.]

DEAR SIR: I am perfectly willing to give you all the information in my power, but hardly know where to begin. I have been subject to the attacks you refer to from the time I was twelve years old, but have never been completely prostrated since my marriage, sixteen years ago.

The disease (or spells, as we call them) would sometimes come on me during the night, and, while feeling all right at bedtime, would be perfectly helpless on waking in the morning. At other times they would come on me gradually, and I could feel myself slowly losing control of my limbs, and finally became helpless; sometimes I could, by keeping in motion, keep from total collapse. I suffered no pain of any description unless my limbs were cramped, but was perfectly helpless, could move neither hand nor foot, but seemed to have complete control of my talking apparatus, and, with the exception of being helpless, I usually felt exceptionally well. My sense of feeling was normal, but the sense of motion completely gone. I noticed that the attacks were more frequent in damp weather; also, that they were sometimes brought on by unusual exertion.

My daughter has suffered from the same disease, but has been completely prostrated only a few times, and as it happened at a time when I was away from home, I will hand your letter to our family physician, Dr. H. L. McIlhenny.

[Copy of letter received from Dr. H. L. McIlhenny, Norwich, Kansas, March 10, 1899.]

MY DEAR DOCTOR: In reply to your letter of February 2d, will say that I am personally acquainted with Mr. W. and family, to whom you refer in your letter.

Referring to the peculiar family affliction, I have to say that I have seen Mr. W. a number of times suffering with these mysterious attacks, though he has suffered but few in the last few years. The condition is surely a most singular one, never having seen any cases like his or his daughter's, and have never seen any authority covering these cases.

Mr. W., I understand, has given you the details of his case, which are evidently very similar to the attacks with which J. suffers. As to Mr. W.'s daughter, who is now about fifteen years of age, I have seen her in this peculiar condition but once, about one year ago, although she has had two or three attacks since, but they were rather light.

At the time I saw her she had gone to bed in the evening as well as usual, and on waking in the morning she found herself completely helpless—paralyzed. I was called and found her in this paralyzed condition—could not move hand or foot. In all respects the attack was similar to those from which her father suffers, except that she suffered quite severe pains in back and head. All reflexes seemed weakened or absent. She remained in this condition ten or twelve hours, when she began to get better, and by the next day she could help herself and began to sit up. In three or four days she was as well as usual. There does not seem to be any regularity in her attacks, nor do I think that menstruation has any relation to the attacks. I hardly think mental emotion or physical exertion are exciting causes. This young lady has been away from home several months attending school, and I have not heard of her having an attack recently. I forgot to say that in this case (Mr. W.'s daughter) I did not make a *careful* examination of the heart, only to note that the heart seemed all right.

The electrical examinations are of great interest and have been often and carefully made by Dr. J. H. W. Rhein, electrician to the Infirmary for Nervous Diseases.

In the first examination during an attack it was impossible to get any reaction either with faradic or galvanic currents in most of the muscles with the largest amount of currents bearable. With from 30 to 40 milliampères slight response could be obtained in the anterior thigh muscles. It was impossible to complete the examination, on account of the pain caused. In examining a large pad was always placed over the sacral region and a small, interrupting electrode over the motor points of the muscle tested. The K. CL. C. contracture was always greater than the AN. CL. C. contracture.

On the second day of the same attack it was possible to get contracture here and there; for instance, the anterior tibial responded with 20 milliampères, the posterior with 18 milliampères, the sciatic nerves with 20 milliampères, and the biceps of the leg with 30 milliampères. No contraction of the rectus femoris could be obtained with less than 30 milliampères. It was necessary to discontinue the examination, as the strong currents made the boy feel faint and decidedly affected his heart.

In a second attack there was no faradic reaction whatever in most of the muscles. In the erector spinæ muscles there was fair contraction

with the greatest amount of current that could be applied. The sternocleidomastoid responded slightly with largest amount of faradic current. This was true also of the other cervical muscles. With the galvanic current no response could be elicited in the cervical muscles with 20 milliampères. It was thought unwise to use larger quantities of this current in the neck region,

Examination in a third attack showed that the anterior tibial muscle responded with 20 milliampères on both sides, the posterior tibial with 12 milliampères on the right side and with 40 milliampères on the left, the erector spinæ with 20 milliampères, the abdominal muscles with 16 milliampères, the biceps, triceps, extensors, flexors, and deltoid responded with currents varying from 30 to 40 milliampères.

In the fourth examination during a mild attack the following conditions were found :

	Right.		Left.	
No contracture with	15	Anterior tibial,	15	No contracture with
	10	Posterior tibial,	8	
	10	Rectus,	18	
	15	Biceps,	15	
	20	Gluteus,	20	
	20	Erector spinæ,	20	
	41½	Flexors,	7	
	6	Extensors,	15	
	10	Triceps,	10	
	10	Biceps,	8	
	12	Pectoralis,	12	
	8	Rhomboid,	8	
	7	Sternocleidomastoid,	8	
	14	Supraspinatus,	12	
	12	Infraspinatus,	7½	
	3	Facial,	4	
	15	Deltoid,	12	
	15	Abdominal rectus,	15	
	15	Lumbar,	15	
	14	Latissimus dorsi,	14	

Biceps and anterior muscles responded very slightly to the greatest amount of current obtainable in a faradic battery, while the rectus and posterior tibial muscles responded fairly well on the left side. The posterior tibial and rectus on the right side reacted better than the biceps and the anterior group on the right side. The flexors of the arms contracted much more readily than the extensors, the biceps more readily than the triceps; the deltoids responded fairly well, the pectorals much more readily, the abdominal muscles only slightly; the infraspinatus responded fairly on both sides. No movement was obtainable in the supraspinatus on either side. The rhomboid muscles contracted quite well.

Median nerve transmission was 15 milliamperes right and left. In order to lessen skin resistance as a factor, examination was also made with the limb immersed in water, but this did not seem to diminish the amount of resistance offered by the muscles to the faradic current.

During a profound attack, in which it required from 20 to 30 milliamperes, CA. CL. C. being greater than AN. CL. C., to develop contraction by the usual method, when a large electrode was placed upon the sacral region and a gold needle inserted deep into the body of a muscle, it was found that fair contracture could be induced with 8 milliamperes, CA. CL. C. greater than the AN. CL. C., interrupting current at the needle insertion into the muscle. On repeating this experiment upon a healthy person it was found that less than half this amount of current was required to evoke contraction in his muscles.

There has never been at any time any suggestion of reversal of the poles; C. CL. C. has always been greater than AN. CL. C. in these examinations.

When the nerves were tested the same lowered irritability was observed—that is to say, if it took 20 milliamperes to induce contraction in a group of muscles, no less was required to bring about contraction when the nerve was stimulated.

Upon examining the patient during the interval and a few hours after the paralysis had disappeared, it was found that the muscles responded normally to faradic and galvanic currents, and that nerve transmission was in no way interfered with. This was repeatedly confirmed.

All these are elaborately detailed, because of the interest which attaches to the very absence of all possibility of stimulation, but may be summed up by saying that during the attack, if it approached at all to completeness of loss of power, no electrical reaction was present to any current which it was possible to use upon a living human muscle, and even when the skin was pierced and electricity applied directly to the muscle a current very much greater than that which would move a muscle in normal condition was required to produce contraction.

The examination of the urine has been most painstakingly made for me by Dr. A. E. Taylor, at the Pepper Clinical Laboratory of the University of Pennsylvania, and his report is as follows:

Urine of Period of Attack, 935 c.c.

Total nitrogen, 13.749 g.	Total phosphates, 1.414 g. P_2O_5 .
Urea, 24.510 g.	Alkaline phosphates, 0.574 g. P_2O_5 .
Urea-nitrogen = 83 + per cent. of total nitrogen.	Earthy phosphates, 0.840 g. P_2O_5 .
Uric acid, 0.526 g.	Total sulphates, 1.356 g. SO_3 .
Xanthin bases, 0.283 g.	Preformed sulphates, 0.140 g. SO_3 .
	Ethereal sulphates, 0.216 g. SO_3 .

Urine of Interval, 1610 c.c.

Total nitrogen, 9.397 g.	Total phosphates, 1.306 g. P_2O_5 .
Urea, 18.490 g.	Alkaline phosphates, 0.494 g. P_2O_5 .
Urea nitrogen = 82 + per cent. of total nitrogen.	Earthy phosphates, 0.812 g. P_2O_5 .
Uric acid, 0.194 g.	Total sulphates, 0.695 g. SO_3 .
Xanthin bases, 0.142 g.	Preformed sulphates, 0.546 g. SO_3 .
	Ethereal sulphates, 0.139 g. SO_3 .

Urine of Period just following an Attack, 1725 c.c.

Total nitrogen, 16.332 g.	Total phosphates, 3.084 g. P_2O_5 .
Urea, 31.111 g.	Alkaline phosphates, 1.999 g. P_2O_5 .
Urea-nitrogen = 88 + per cent. of total nitrogen.	Earthy phosphates, 1.085 g. P_2O_5 .
Uric acid, 0.297 g.	Total sulphates, 2.174 g. SO_3 .
Xanthin bases, 0.090 g.	Preformed sulphates, 1.975 g. SO_3 .
	Ethereal sulphates, 0.199 g. SO_3 .

Urine of Period of Attack, 1550 c.c.

Total nitrogen, 7.247 g.	Alkaline phosphates, 1.163 g. P_2O_5 .
Urea, determination spoiled.	Earthy phosphates, 0.620 g. P_2O_5 .
Uric acid, 0.103 g.	Total sulphates, 0.652 g. SO_3 .
Xanthin bases, 0.0214 g.	Preformed sulphates, 0.561 g. SO_3 .
Total phosphates, 1.783 g. P_2O_5 .	Ethereal sulphates, 0.089 g. SO_3 .

Each set of analyses comprises the figures for the urine of twenty-four hours. The first two sets were done in the period when the patient was upon milk diet; the last two were done while the patient was upon a mixed diet.

The total nitrogen and the urea, as well as the ratio between the urea-nitrogen and the total nitrogen, were within normal limits, in consideration of the diet.

The quantities of uric acid were, with the exception of the first analysis, notably low. There was, however, no constant relation; the highest and lowest figures were gotten for the urine voided during attacks, while the figures for urine voided between the attacks lie between them. Such fluctuations may, however, be seen in the urine of healthy people.

The xanthin bases were in three of the four examinations excessive. In the urine of the last attack, however, the quantity was entirely normal. Such a quantity as 0.090 g. may often be seen in various diseased states, but figures such as 0.283 g. are rarely seen outside of leukæmia. Whether the quantities of uric acid were small because the xanthin bases were eliminated as formed and not oxidized to uric acid cannot be shown.

The elimination of total phosphates was within the normal limits. In the first two analyses a reversion of the normal ratio between the alkaline and the earthy phosphates was determined; in the last two analyses the ratios were normal. This reversion of the ratio between

the alkaline and earthy phosphates is considered by Gilles de la Tourette to be diagnostic of hysteria. It is, however, found in very few cases of hysteria in this country.

The total sulphates were in all analyses within the normal limits. The normal figures for the preformed sulphates indicate that the proteid metabolism was normal. The quantities of ethereal sulphates were low. The diet and the colonic lavage obviously have tended to limit the formation of the ethereal sulphates, and the figures certainly indicate that there was no excess of proteid decomposition in the alimentary tract.

The urine of twenty-six days, including three attacks, was carefully tested for ptomaines, alkaloids, and alkaloidal substances by the Brieger and the Baumann-Udransky methods. No trace of such substances could be detected. These tests do not reveal bacterial toxins in the true sense of the term, and a rôle on their part in the case cannot be excluded.

The urotoxic coefficient (determined according to the Bouchard method, except that the injections were done under slight ether narcosis into the jugular vein) was below 0.536 for the urine voided during the attack and below 0.557 for the urine voided between the attacks—I say below, because in each case the injection was stopped at a point when the rabbits were apparently dying, but in each instance the animal recovered. In consideration of the diet, of the fact that the man was in bed, and that the injections were made into the jugular vein, the urotoxic coefficients were normal. The close approximation of the coefficients in and after the attack is striking, and speaks against regarding the seizures as corresponding to variations in the urinary toxicity. As a matter of fact, the Bouchard procedure is crude, and under all circumstances furnishes results of doubtful value. I do not believe the negative results in these injections can be taken as a serious consideration against the view that the seizures may have a toxic cause. Chemical and bacterial studies of the feces during and after several attacks gave wholly negative results, which it is not necessary to detail.

Studies of the blood under the microscope revealed little or no changes. No malarial protozoa could be found in any form. With stained slides the relative proportions and staining reactions of the different elements were found unaltered. Counts of the red and white corpuscles gave normal results, and the percentage of hæmoglobin was always high, never having been found below 90.

I asked my friend, Dr. Alfred Stengel, to repeat these examinations, which were made by myself and by my hospital assistants, that I might have the advantage of an authoritative opinion, and to undertake some experiments to determine the toxicity of the blood-serum. In bleeding the patient, to secure the necessary amount of blood for these experi-

ments, a remarkable difficulty was experienced. When the median cephalic vein was opened during an attack the flow of blood was so slow and so small that we could hardly secure the six ounces we wanted. Thinking the opening in the vessel had not been large enough, on another occasion we cut the vein right across, but with scarcely a better result. The patient's heart-action at the time was, as usual in the paroxysms, rather rapid and feeble, with lowered pulse-tension, and on the occasion when we abstracted the full six ounces he felt decidedly light-headed before the bleeding ceased.

Dr. Stengel's report is as follows:

"November 22, 1898. 1. Five c.c. of serum from blood drawn during an attack injected into rabbit weighing 1550 grammes at 4.30 P.M. Was well at 6 P.M.; died during the night. Post-mortem showed abundant hemorrhages at base of right lung; less at left base. No other changes of a definite sort.

"23d. 2. Injected with same serum, 2½ c.c., rabbit No. 2. One hour after: Red corpuscles, 5,012,000; white, 9800. Twelve hours later: 6,000,000 red cells and 11,550 white.

"April 28, 1899. 3. Injected 5 c.c. of serum into rabbit weighing 2250 grammes. Rabbit alive after forty-eight hours.

"4. Injected 9 c.c. into rabbit weighing 2150 grammes. Died in thirty-six hours."

These, like the examinations of the secretions, may be said to give negative results, and certainly do not indicate any unusual degree of toxicity in the blood.

The consistency of the manifestations in the attacks is remarkable. In twenty-five attacks observed the only difference was in the degree to which power was lost, the more or less total disappearance of reflexes, and the varying occurrence of certain changes in heart-action and pulse-tension.

Almost all of the eighteen or twenty cases observed by various writers in Europe and in this country have presented symptoms very closely alike. In almost all paralysis has been periodic in its occurrence; generally there have been instances among relatives of the sufferer; in none have any sensory changes been found, and in those in which electrical study has been made electrical changes which greatly resemble the ones here described have been present, and in the intervals of the attack the patients almost invariably give the same history of complete and perfect strength and soundness.

I say that in all the cases there have been practically no sensory changes. One described by Fischl had distinct impairment of sensibility. This case is in other ways a rather doubtful one, and might perhaps be excluded from the list.

Oppenheim and Hirsch both describe temporary slight increase of

cardiac area, and both have observed murmurs upon which the diagnosis of probable mitral insufficiency was founded, a condition which lasted only during the paralysis and disappeared rapidly with the loss of power.

In one of Goldflam's cases irregularity was observed and a faint, systolic basic murmur. In mine, as has already been indicated, there was a murmur, limited to the left edge of the sternum, and best heard at the pulmonary area. This condition has varied very much in the different attacks, but this is the one which is the most common. As a rule, J.'s heart is faster in the attacks than out of them, in spite of the complete absence of muscular movement. A slight accentuation of the second sound with a tendency to splitting is present even in the intervals.

The examinations of the blood, feces, and urine have been made in most careful and detailed manner, and the results herewith call but for one comment—namely, that most minute study has revealed no fact of importance in any of them, and in the two or three cases in which these points have been thoroughly gone into, almost equally little has been learned from the examinations.

As to treatment, it may be readily supposed that this has been experimental. For several weeks during the early observations J. was not given any medicine, but led a perfectly regular and wholesome if somewhat inactive life. This was thought advisable, in view of the fact that several cases have described their paralyzes as brought on by over-exertion. No such cause could be assigned in the present instance, as for some weeks he lived in the hospital ward and moved about the building freely, taking the ordinary liberal house diet and being under close observation. The first theory which suggested itself, as it has to other observers, was that the trouble had an autotoxic origin. In order that there should be no retention of feces in the intestinal canal to favor this the colon was carefully washed out every second day. During this period attacks occurred exactly as regularly as they had before he came to the hospital. He was then put to bed and kept upon milk diet; the colon washing was continued, and various intestinal antiseptics were used. The attacks recurred with about the same interval as before. He lost a little weight upon this treatment, during which also massage was used, for the sake of keeping up his circulation and of anticipating the impairment of digestion from inactivity. It was during this time that the first studies of the urine were made by Dr. Taylor, and his examination showed one of the effects of colon lavage in the absence or lessening of the ethereal sulphates. Finding the paroxysms recurring as before, he was allowed to get up and move about a little, but the amount of milk was increased, and soon after he was returned to a house diet. At this time the later examinations of the urine were made. No evidence having been secured from the urinary and fecal

examinations of any toxic condition, intestinal antiseptics were stopped and an attempt was made by the use of full doses of strychnine to stimulate the spinal cord, upon the secondary assumption that this might be the source of the disturbance. Full doses of strychnine were given and rapidly increased, and if any change took place in the patient it was that the attacks appeared at rather shorter intervals than before. Strychnine had a very decided effect upon him, and it was not long before it had to be stopped. For a time he was left without any treatment, with orders to the hospital people to occupy him as much as possible and to let him go out every day for a walk. No decided difference in the frequency of paroxysms appeared under this regime, and for a time under no treatment at all the attacks, without evident cause, grew somewhat more frequent and recurred several times with only three or four days' intermission. Bromide was then given, and the first week of its administration in doses of twenty grains three times a day there was no "spell," although just previously the intervals between the attacks had been, at the utmost, four days. He was rather long in the next seizure, which was a very complete one, and when he recovered from it he had a week during which the knee-jerks were irregular—sometimes absent, sometimes slightly present—and in this whole period the patient felt dull and not so strong as usual upon his feet.

Little as we have discovered of any unusual condition of the blood, feces, or urine in this case, it seems to me impossible to attribute the attacks to any other than a toxic cause, even in face of the negative results of the chemical studies. The analogy is sufficiently striking to some other autotoxic, or partially autotoxic, disorders, in spite of the want of direct findings to support this view, and in spite of the fact that some aspects of the case are against it.

In migraine, for example, we have an instance of a disease in which family tendency is strongly evinced, which usually begins at about the age of puberty and lessens or disappears in middle life, which occurs paroxysmally and often at fairly regular intervals. The manifestations of migraine are largely cerebral, and those of the disorder we are considering appear in the spinal centres and peripheral nerves and muscles.

As to other possibilities, it has been variously suggested that, as in the cases described by Higier, and lately in Philadelphia by Dr. J. W. McConnell, the attacks are the paralytic equivalents of epileptic fits. But in the instances where paralytic seizures have replaced epileptic paroxysms no alteration in electrical reactions have been found, so far as I know, nor any loss of reflex and direct muscular irritability, nor are heart-murmurs produced. The perfectly clear mind of the patient throughout the attack is also against this supposition, and so is the long duration of the palsy.

The suggestion of hysteria is scarcely necessary to discuss. The altered electric reactions, the absence of reflexes, and the perfectly well-balanced, wholesome moral tone of the patient at once negative this.

A poison, or more than one poison, formed at intervals or constantly formed and gradually accumulating, and acting severally upon the heart and vessels, the spinal centres, as shown by the sexual excitement, and upon peripheral nerves and muscles, is the most warrantable conclusion. It is difficult to imagine one toxic material which should have all these effects; but certainly no one could study this boy's state and not have poisoning suggested to his mind. The heavy breath, the coated tongue, the comparative suppression of urine during the attack, with an unusual flow after, all carry out the analogy to migraine. If one poison might act upon both spinal centres and peripheral nerves and muscles, it is, perhaps, not too fanciful to account for the heart conditions by supposing that the resulting total flaccid palsy may extend to the muscles of the arterial system, and that this relaxation allows of so much dilatation of the great vessels as to favor the production of a murmur.

Some additional testimony to a special action of the poison upon the cord may be drawn from the examination of the patient's mother, in whom there was distinct, if slight, enfeeblement of function in the lower spine.

On the whole, upon due consideration of all the cases that can possibly be included in periodic family paralysis, it appears to be a warrantable conclusion that two poisons are formed, one of which predominates in some cases, another in other cases; according to the predominance of one or the other, the effect is greater upon the peripheral nerves and muscles or upon the spinal centres. The disease is remarkable in this that it is clinically a most distinct entity, that all observers agree in their statements of the vast majority of symptoms, and that up to the present time the causation and pathology of the affection remain in absolute darkness.

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