it no longer seems desirable to continue the use of the term "lentic zone."

The term "meningitic zone" is not open to such strong objection as the others, inasmuch as it is but rarely that other conditions give curves simulating it. However, for uniformity's sake, we feel that it could well be called the "third zone."

CONCLUSIONS

1. In the acute stage of poliomyelitis, the spinal fluid reacts with colloidal gold in dilutions of from 1:40 to 1:160, producing a maximal decoloration of 3 ("blue").

2. In the second and third weeks the reaction is practically the same as in the acute stage, with a tendency to clear up in some cases and a precipitation in the higher dilutions in others. There is no constant rule.

3. In the fourth to the eighth week the colloidal gold reaction runs practically to the globulin-albumin content, persisting in some cases to the eighth week and

CLINICAL STUDY OF FOUR HUNDRED CASES OF ANTERIOR POLIO-MYELITIS*

SAMUEL A. JAHSS, M.D.

Orthopedic Assistant, Hospital for Deformities and Joint Diseases

NEW YORK

My object is to present the observations obtained by a close study of 400 cases of anterior poliomyelitis of the 1916 epidemic, seen at the clinic of the Hospital for Deformities and Joint Diseases.

These cases made their appearance at an average of about ten weeks after onset of illness, and show: (1) regional distribution; (2) a large amount of cranial nerve involvement; (3) muscular distribution; (4) unreliability of the reaction of degeneration to permit judgments concerning the extent of muscle paralysis, and (5) numerous deformities.

1. Of the entire series, thirty-two patients, or 8 per cent., showed no evidence of muscle paralysis. Of the

TABLE 3.—CONVALESCENT STAGE, FOURTH TO EIGHTH WEEK

No.	Name	Age, Years	Day of Disease	Cells per C.mm.	Ross-Jones	Pandy	Wassermann Reaction		Colloidal Gold Reaction									
							Antigen		Dilution of Cerebrospinal Fluid									
							A	B	1:10	1:20	1:40	1:80	1:160	1:320	1:640	1:1,280	1:2,560	
							.25	.5	.25	.5								
P. 93	Herbert.....	8	22	18	++	++	0-0	0-0	1	1	2	2	2	1	0	0	0	
P. 71	Lloyd B.....	3	27	1	+	+	0-0	0-0	1	1	1	2	2	0	0	0	0	
P. 100	Norman D....	3	28	4	++	++	0-0	0-0	1+	2	2+	2+	2+	2+	0	1	0	
P. 65	John J.....	8mo.	28	4	+	+++	0-0	0-0	1	1+	1+	3	2	1	0	0	0	
P. 91	Malcolm S....	3	28	2	0	+	0-0	0-0	1	1	1+	2	2	1	0	0	0	
P. 94	Elmer L.....	6	29	3	+	+	0-0	0-0	+	1	1+	1+	1	+	0	0	0	
P. 74	Mildred W....	9mo.	31	15	++	++	0-0	0-0	1	1+	2	2+	1+	1	+	0	0	
P. 88	James E.....	3	32	4	0	0	0-0	0-0	0	0	0	+	0	0	0	0	0	
P. 100	Norman D....	3	32	4	+	+	0-0	0-0	1	1+	1+	2	2	1	0	0	0	
P. 84	Luber F.....	3	35	2	+	+++	0-0	0-0	1+	1+	1+	2	1	1	0	0	0	
P. 47	Emily W.....	6mo.	37	4	++	++	0-0	0-0	1	1	1	2	3	2	1	1	0	
P. 56	Dillalunt....	21mo.	39	8	0	0	0-0	0-0	+	+	+	0	0	0	0	0	2	
P. 58	Hoffman.....	0	39	8	+	+++	0-0	0-0	2	2	2	2+	3	3	1	1	0	
P. 68	Fisher.....	3	39	1	+	+	0-0	0-0	+	1	1+	1+	1	+	0	0	0	
P. 70	Alfred E.....	6	39	1	++	++	0-0	0-0	+	+	1	2	2+	2	+	0	0	
P. 46	Gladys D....	4	40	2	++	++	0-0	0-0	0	0	+	1	1	+	0	0	0	
P. 42	Kathrine W....	2	40	4	+	+	0-0	0-0	1	1+	2	2	2	1+	1	0	0	
P. 30	John B.....	10	42	6	++	+	0-0	0-0	0	+	1*	2	1	+	0	0	0	
P. 37	Lillian L....	2	42	6	++	++	0-0	0-0	1	1	2	2	2+	1	0	0	0	
P. 45	Anna V.....	4	42	4	+	+	0-0	0-0	1	1	1+	2	2	1	0	0	0	
P. 43	Susie B.....	2	42	13	+	++	J-0	0-0	0	+	1	1+	+	0	0	0	0	
P. 55	Benj. B.....	15mo.	44	1	0	+	0-0	0-0	1	1	2	1	1	0	0	0	0	
P. 82	Naomi L....	1	46	2	++	++	0-0	0-0	1	1	1+	2	2+	2	1	+	0	
P. 26	Dorothy H....	4	50	2	++	++	0-0	0-0	1	1+	2	2	1+	+	0	0	0	
P. 27	Carr.....	3	52	3	+	+	0-0	0-0	1	1+	2+	3	3	1+	1	0	0	
P. 17	Eshbury.....	15mo.	52	4	+	+	0-0	0-0	1	1	1	1	1+	2+	3	0	0	
P. 19	Mildred.....	3mo.	54	3	+	+	0-0	0-0	1	1	2+	2+	1	0	0	0	0	
P. 48	Mary B.....	4	45	3	+	+	0-0	0-0	1	1+	3	3	2	1	1	0	0	
P. 90	William M....	2	0	2	0	0	0-0	0-0	1	1	1	1	0	0	0	0	0	

beyond, but still occurring in dilutions of from 1:40 to 1:160.

4. As the spinal fluid in acute poliomyelitis reacts constantly in the same zone, the gold chlorid reaction is helpful in the diagnosis of this disease.

5. We deem it advisable to use the following nomenclature in reading the reactions of Lange's colloidal gold test:

- Zone 1 (or paretic zone), maximum precipitation from 1:10 to 1:160, with complete decolorization.
- Zone 2, maximum precipitation from 1:40 to 1:160, with decolorization up to 4 (light blue).
- Zone 3, maximum precipitation beyond 1:160.

A Pessimistic View of Man.—What a chimera, then, is man! what a novelty, what a monster, what a chaos, what a subject of contradiction, what a prodigy! A judge of all things, feeble worm of the earth, depositary of the truth, cloaca of uncertainty and error, the glory and the shame of the universe!—Pascal, Thoughts.

remaining 368 patients, 286, or 78 per cent., showed some involvement in the lower extremities. Thirty-eight per cent. showed involvement of only one limb. Of this number, 10 per cent. were of the upper extremity and 28 per cent. of the lower. In 20 per cent. of the cases there was some form of trunk paralysis, showing that it has been quite a common occurrence. The right and left sides of the body were equally attacked.

The extent of paralysis differed from a part of one leg to an involvement of both legs, both arms, both sides of the abdomen and back, and also the larynx, which is slight. Between these two extremes there was seen every conceivable type of combination obtainable. Table 2 illustrates this very clearly.

2. In fifty-one cases, or 13 per cent., the cranial nerves were involved. In six cases, two different nerves were involved at the same time. The fifth nerve was affected 1 time; the sixth nerve, 1 time;

* Read before the Clinical Society of the Hospital for Deformities and Joint Diseases, Dec. 28, 1916.

the seventh nerve, 38 times; the tenth nerve, 4 times, and the eleventh nerve, 13 times.

3. In past epidemics, it seems that the muscles most often attacked in the leg were the peroneals; during the present epidemic it has been the tibialis anticus and quadriceps extensor which have most often suffered.

TABLE 1.—REGIONAL DISTRIBUTION

Region	No. Cases Involved	No. Parts Involved	Right	Left	Involved Alone	In Combination
Leg	286	437	207	230	183	103
Arm	111	139	72	67	45	66
Face	38	...	19	19	24	14
Abdomen	46	79	35	44	1	45
Back	53	91	44	47	...	53
Neck	3	4	3	1	...	3
Sternomastoid	2	...	...	2	...	2
Larynx	3	...	...	...	...	3
Palate	3	...	...	...	...	3
Jaw	1	...	...	...	1	...
Eye	1	...	...	...	...	1

In the arm, the discrimination for the deltoid is again shown, followed by the pectorals, etc. (Table 3).

Not all the muscles were completely paralyzed, as there was some degree of motion in about 25 per cent. of all muscles involved.

The most frequent combination of muscles attacked in the leg has been those supplied by the anterior tibial nerve.

In the thigh, the quadriceps, adductors and hamstrings have shown a distinct tendency to be involved together (a mixture of both the lumbar and sacral plexuses).

When the external rotators of the hip were involved, the internal rotators always accompanied them. In no case were they affected alone. In the arm, the deltoid, pectoralis major and latissimus dorsi have been closely associated in paralysis. The latissimus dorsi

TABLE 2.—EXTENT OF PARALYSIS

One leg	111
Both legs	72
One arm	41
Both arms	4
All extremities	5
Three extremities	9
Arm and leg (same side)	6
Arm and leg (opposite side)	5
Trunk	2
Face alone	24
Jaw	1
Arm, leg, face (left)	1
Leg and back*	21
Leg and abdomen*	10
Leg, abdomen and arm*	10
Leg, abdomen and back*	6
Leg, back and arm*	6
Arm and back*	2
Arm and abdomen*	2
Leg and face*	5
Arm and face*	2
Leg, arm, back and neck*	2
Leg, arm, back and abdomen*	8
Leg, back, abdomen and larynx	2
Arm, palate and face*	1
Leg, palate and face*	1
Face and eye*	1
Leg and sternomastoid*	1
Arm, face and sternomastoid*	1
Arm, back and abdomen*	1
Leg, arm, abdomen and face*	1
Leg, arm, abdomen, face and back*	1
Leg, arm, abdomen, back and neck*	1
Leg, arm, abdomen, back and larynx*	1
Leg, arm, abdomen, back and palate*	1
Cases showing no paralysis	32
Total	400

* It may be one or both in any of the parts affected; in order not to lengthen the list, this is not specified.

was affected in fifty-one cases, and in fifty of these the foregoing took place. The "upper arm type" or the "forearm type" of paralysis did not occur in any instance.

4. To judge the extent of muscle paralysis by the reaction of degeneration is entirely fallacious. Muscles showing absolutely no action have given normal elec-

trical reactions both to faradic and to galvanic currents. Some, with partial motion, showed various degrees of electrical degeneration, and in one or two instances, a complete reaction of degeneration was obtained, that is, failure to respond to faradism (moderate strength) and also to galvanism at 15 milliamperes both to the cathodal and to the anodal closing and opening currents.

Whether a true prognosis as to ultimate recovery may be given judging by the reaction of degeneration will be brought out in a later paper.

5. In only a few instances, comparatively speaking, was the deformity of talipes equinus encountered. Of the others, especially in the upper extremity, there were many.

Too much stress cannot be laid on the prevention of deformity.

It must be borne in mind that practically every group of muscles has an antagonistic group. The

TABLE 3.—MUSCULAR DISTRIBUTION

Muscle	Involved	Partial	Complete
Tibialis anticus	369	101	268
Quadriceps extensor	302	78	224
Peronei (longis and brevis)	251	62	189
Hamstrings	222	77	145
Gastrocnemius and soleus	215	52	163
Extensor longus digitorum	215	66	149
Extensor longus hallucis	215	65	150
Adductors	205	44	161
Internal rotators	173	18	155
Tibialis posticus	171	10	161
Iliopsoas	147	55	92
Gluteus maximus	127	32	95
Flexor longus digitorum	97	29	68
Flexor longus hallucis	97	29	68
External rotators	76	18	58
Deltoid	119	37	82
Pectoralis major	88	25	63
Triceps group	65	30	35
Biceps group	58	24	34
Latissimus dorsi	51	10	41
External rotators	43	1	42
Extensor communis digitorum	34	18	16
Internal rotators	31	3	28
Supinator longus and brevis	26	5	21
Flexor carpi radialis and ulnaris	22	11	11
Extensor longus pollicis	22	12	10
Flexor sublimis and profundus digitorum	20	10	10
Pronator teres (group)	19	6	13
Flexor longus pollicis	16	8	8
Extensor carpi radialis longior and brevis, and extensor carpi ulnaris	15	8	7
Serratus magnus	11	3	8
Trapezius	9	5	4
Rhomboid group	4	...	4
Thenar eminence	3	...	3
Lumbricales and interossei	2	...	2
Abdomen	79	28	51
Back	91	36	55
Face	38	12	26
Neck	4	2	2
Larynx	3	3	...
Palate	3	3	...
Jaw	1	1	...
Sternomastoid	2	2	...
Eye	1	1	...

flexors have the extensors, the inverters, the everters, the abductors, the adductors, the internal rotators, the external rotators, etc.

The possibility of flexion deformity at the knee, hip, fingers, wrist and elbow are just as favorable as one at the ankle (talipes equinus).

A healthy latissimus dorsi with a paralyzed deltoid will do just as much damage in the shoulder as a healthy gastrocnemius and soleus muscle with a paralyzed tibialis anticus will do in the ankle.

Nearly every patient having tibialis anticus paralysis had either a posterior splint or some other form of retentive apparatus to prevent the deformity of talipes equinus. Yet there was absolutely no appliance of any sort to prevent a paralytic deformity in: (1) 90 per cent. of shoulder patients having deltoid paralysis; (2) those having a paralysis of half the back; (3) those having a paralysis of half the arm; (4) those in whom the abdomen was completely paralyzed and

the children walk with extreme lordosis; (5) those having a paralysis of the internal rotators of the hip with good strong external rotators, and (6) those in whom the calf muscles were paralyzed and the children walked on their heels.

Why more importance should be attached to a prevention of talipes equinus than to any other form of deformity, which often proves of a more serious nature, is incomprehensible. One deformity is as bad as another, if not worse.

Any joint in the body in any of its functional directions may be the seat of deformity.

Every deformity results in stretched muscles which markedly lessen the patient's chances for recovery, a state of affairs entirely unnecessary and easily prevented.

1444 Bryant Avenue.

FALLACY OF DENYING FUNCTIONAL SIZE CHANGES IN NERVE CELLS FROM COLLECTIVE CELL AVERAGES*

DAVID H. DOLLEY, M.D.

Professor of Pathology, University of Missouri, School of Medicine
COLUMBIA, MO.

Kocher¹ has recently published several papers which make a sweeping denial of any morphologic evidence of functional activity in nerve cells. He bases this conclusion chiefly on his failure to find constant differences in the average size of cells between exercised and undisturbed animals. In these measurements, he employed the polar planimeter, which gives from camera lucida outlines the exact area of cells in microscopic sections.

It became necessary for me² to test my own positive results for functional activity by this method, particularly since Kocher's destructive criticism was directed mainly at myself. From long experience, however, with the polar planimeter in calculations from individual cell reconstructions, there was no reason beforehand to expect any important differences.

The planimeter was tested, not by averaging all cells measured from any region irrespective of their functional stage, as Kocher did (collective averages), but by applying it to the same number of cells from every functional stage. Data of diameter measurement with volume estimation, which has been my method, were obtained concurrently from the same series from an exercised and control animal, in order to compare the two methods. A graphic charting of the data shows that the two methods afford results absolutely identical in every detail, both in size and in nucleus-plasma relations. Previous conclusions for functional size changes and species size relations are verified.

The value of the planimeter method is as a mutual check on the diametral method. Alone it has no special or superior value; but since it gives only two dimensions, with smaller variations than in volume calculations, it is quantitatively misleading.

Kocher's method, therefore, has no peculiar applicability in settling the problem. It remains to point out that his handling of the data by means of collective averages, which has been in fact the usual procedure, involves just the inconstant results which he obtained. If one measures the individual stages correlated as functional, he will find very wide variations in their size in any cell type in the same animal. For example, the stages of shrinkage first described by Hodge³ are only one-half the area and one-fourth the volume of cells approaching chromatic exhaustion. The resting cell type is only one-half the volume of the initial enlargement of function. In their function, cells first enlarge, then they shrink, and from that shrinkage progress to a secondary enlargement. Is it not obvious to any one that when two animals are compared on this basis of averaging all cells together, the result depends on the distribution of cells and a wide range of results is possible? The comparison may or may not prove anything about the functional state. It is possible in two combinations of cells closely related in degree of function that one would run smaller, the other larger than the average.

In illustration, Hodge found a smaller size in the stimulated ganglion as compared with the unstimulated, because the majority of cells were in a state of shrinkage. But as they pass from this state of shrinkage to a progressive hypertrophy in prolonged stimulation, enough of these larger cells would first equalize a comparison, and then turn the average the other way. So Kocher did not consistently obtain Hodge's results. Yet, as a matter of fact, accepting the smallest differences, he did duplicate Hodge's results in eleven out of fifteen series from the spinal cord and associated ganglia, and the exceptions which misled him follow to a noticeable degree the explanation given.

Further, as Kocher dealt with areas and ignored the third dimension, it follows that there was less range of variation in the quantitatively smaller area figures, and the averaging had smaller differences to smooth out in the same animal. That is, a preponderance of large cells or of small cells would have less effect.

It is not a matter of chance that the cell sizes in Kocher's case approximated each other so closely in contrasted animals, but an actual basis can be stated for it. This is the tendency to a uniformity of absolute size for corresponding nerve cells of a species. For this the theoretical basis is that function is the sole determinant of absolute size in such a specialized cell. It is understandable on the basis of average general functional usage. The exceptions thereto so far have been the functional oversize, the functional hypertrophy and the functional undersize, the atrophy, used in this general sense to include functional disuse, depression effects, and lack of functional development. It makes the nerve cell agree with Conklin's⁴ conclusion that within the same species cell size is practically constant. It is admittedly not demonstrated in the great number of individual instances required as an induction. But Kocher's small differences between an animal and its control are understandable on this basis, and the results, so far as they prove anything, confirm the tendency to this size uniformity. The induction relates specifically to the resting cell type, but the distribution of functioning cell sizes above and below it would make the averaging of all cells approximate a common size. Certainly, such results do not con-

* Read before the American Association of Anatomists, New York, December, 1916. Complete data will appear in the *Journal of Comparative Neurology*.

1. Kocher, R. A.: *The Effect of Activity on the Histologic Structure of Nerve Cells*, *THE JOURNAL A. M. A.*, July 22, 1916, p. 278; *Jour. Comp. Neurol.*, 1916, **26**, 341.

2. Dolley, D. H.: *Jour. Med. Research*, 1909, **20**, 275; 1909, **21**, 95; 1910, **22**, 331; 1911, **24**, 309; 1911, **25**, 285; *Am. Jour. Physiol.*, 1909, **25**, 151; *Jour. Comp. Neurol.*, 1914, **24**, 445; *Arch. f. Zellforsch.*, 1913, **9**, 485; *Anat. Rec.*, 1916, **10**, No. 3.

3. Hodge, C. F.: *Jour. Morph.*, 1892, **7**, 1.

4. Conklin, E. G.: *Jour. Morph.*, 1912, **23**, 159.