

diminishes the apparent importance of the pelvic zone as compared to the others.

Tables 3 and 4 strikingly illustrate the greater frequency of habit-movements in the paralytic as contrasted with those in the active juvenile idiots. Tables 2 and 3 contrast the relative preponderance of habit-movements in the juvenile idiots over those seen in the adult cases; and the inverse frequency of masturbators in these two classes.

TABLE 3.—ANALYSIS OF 223 ACTIVE BOY AND GIRL IDIOTS UNDER PUBERTY

	Boys (150)	Girls (73)
Pleasure-suckers .....	17	17
Biters .....	9	9
Face- and lip-strokers.....	13	0
Pelvic rotators .....	4	0
Pelvic rockers and swayers.....	10	10
Fingers in eyes.....	0	9
Head-rubber or pounder.....	0	2
Palm- and finger-rubbers.....	0	3
Total habit-movements.....	53	50
Masturbators .....	3	12
Masturbators (both sexes).....		15
Habit-movements (both sexes).....		103

TABLE 4.—ANALYSIS OF SIXTY-SIX PARALYTIC BOY AND GIRL IDIOTS UNDER PUBERTY

	Boys (47)	Girls (19)
Pleasure-suckers .....	23	12
Pelvic rockers and swayers.....	8	6
Rotators .....	3	0
Total habit-movements.....	34	18
Masturbators .....	2	1
Masturbators (both sexes).....		3
Habit-movements (both sexes).....		52

TABLE 5.—CLASSIFIED GROUPING OF 201 CASES OF HABIT-MOVEMENTS, ARRANGED WITH REFERENCE TO THE LOCATION OF THE EROGENOUS (FREUD) ZONES

Face and head zone, total.....	123
Pleasure-suckers (fingers, rags, tongue, lips, etc.)..	75
Biters (hand, tongue, etc.).....	14
Strikers and rubbers of eyes.....	13
Strokers of own or other faces.....	13
Pounders of face and head.....	6
Aural inserters (fingers and foreign substances)....	2
Pelvic zone.....	66
Pelvic rockers.....	12
Rockers and swayers.....	54
Hand zone.....	12
Rubbing, pulling, entwining fingers and hands.....	

TABLE 6.—SHOWING RESULT OF OSMOPHORECTOMY ON SEXUALITY IN IDIOCY AND FEEBLE-MINDEDNESS \*

Name	Age (Yrs.)	Time Observed	Result
M. B. ....	21	2 yrs., 5 mos.	Made worse.
E. L. ....	31	4 mos.	.....
L. R. ....	14	2 yrs., 1 mo.	Improved.
M. H. ....	22	6 mos.	Unchanged.
M. R. ....	22	8 mos.	Made worse.
R. M. ....	14	4 mos.	Improved.
R. H. ....	..	5 mos.	Made worse.
L. G. ....	37	9 mos.	Made worse.
K. D. ....	23	6 mos.	Improved.
S. C. ....	30	2 yrs., 5 mos.	Improved.
A. D. ....	25	7 mos.	Made worse.
C. H. ....	20	2 yrs., 10 mos.	Improved.
F. F. ....	16	1 yr., 5 mos.	Unchanged.
D. M. ....	23	2 yrs., 4 mos.	Unchanged.
J. B. ....	29	3 mos.	Improved.
L. W. ....	43	2 mos.	Unchanged.
B. T. ....	15	2 yrs., 1 mo.	Unchanged.
S. S. ....	..	2 mos.	Improved.
C. R. ....	17	6 mos.	Improved.
L. J. ....	20	11 mos.	Unchanged.
L. F. ....	18	2 yrs., 3 mos.	Unchanged.

\* This table is inserted through the courtesy of the Randall's Island surgical staff, who operated for diseased conditions and for other purposes than those of this paper.

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## A NEW METHOD FOR CONTROLLING THE ADMINISTRATION OF SERUM IN EPIDEMIC MENINGITIS.

PRELIMINARY NOTE \*

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At present I am compiling my records of about 200 cases of meningitis in which, in all, about 600 lumbar punctures were done. Most of the cases were studied in the present epidemic at Dallas, Tex. I thought it would be desirable, before waiting for the compilation of the complete records, to write a preliminary note on an improvement in the method of administering intraspinally the antimeningitis serum which I have been using for the past seven months and which I believe has now definitely proved its efficiency and superiority over the old method of administration.

The present method of standardizing the antimeningitis serum, as generally accepted, is by determining the opsonic index and by similar immune-serum tests. There is, however, no measure of efficiency placed on the serum such as we have in the case of diphtheria or tetanus antitoxin; the dose is therefore measured entirely by volume. Since the serum acts principally by its local action, the idea was, and still is, to introduce as much serum as possible without injury. It was believed that, after removal of a quantity of cerebrospinal fluid by lumbar puncture, one could, to a certain extent, reestablish conditions in the central nervous system by injecting an equal or slightly smaller volume of serum. Thus in an ordinary, moderately severe, case in an adult, if one withdrew 45 c.c. of cerebrospinal fluid, an injection of 30 c.c. of serum would be safe and ample, while in a severe case one would be justified in injecting 45 c.c. or more of serum.

It is seen by analyzing this method that one hopes and believes that conditions are established, but one has no proof. On this assumption many severe symptoms occurring either during or a few hours after an injection had been attributed to the disease proper. Undoubtedly toxemia, in some cases, accounts for the symptoms; an analysis, however, of many cases would make one suspicious that possibly the symptoms, in some, were the direct result of the injection, especially when they occurred immediately during or after the operation.

I had been dissatisfied with the old method for a long time. There was no reliable guide indicating the quantity of serum one could safely inject. It occurred to me that if one could make determinations of the cerebrospinal fluid pressure during the operation, one might so have a definite guide, the idea being to inject serum only in sufficient quantity to bring the cerebrospinal fluid pressure to the original reading before the removal of fluid. In that way one would cause least disturbance or shock. To obtain such result was evidently the reason for instituting the old arbitrary method. I therefore began to take cerebrospinal fluid pressure readings during the puncture. After withdrawing a quantity of fluid, which reduced the pressure to normal, I attempted to inject serum in sufficient quantity to raise the pressure to the original reading before the removal of fluid. Thus, if the initial cerebrospinal fluid pressure reading was 400 mm. (water-pressure), I removed the fluid till the pressure dropped to normal, or below,

\* From the Research Laboratory of the Department of Health, New York City.

usually to between 20 to 100 mm. I then attempted to inject serum in sufficient quantity to raise the pressure to about 400 mm. I shall not cite cases in this paper; the results by this method, however, were misleading and unreliable as indicating the true intracranial pressure. Theoretically one would expect a return to the original pressure on injecting a volume of serum equal to the cerebrospinal fluid withdrawn; this was not the case. One could inject even larger quantities of serum than fluid withdrawn, but the pressure-readings were frequently lower than the initial reading before the removal of fluid. Even with readings showing a lower intracranial tension after the injection of serum, one would meet severe, even very dangerous, symptoms. I learned very quickly that this method was misleading and even dangerous. I believe that the error was very probably mechanical and that the later readings were not a true index of the intracranial tension. It is very probable that injecting serum, even with little pressure, would produce a local distention of the subarachnoid space at the site of injection and give readings which did not make a true picture of the uniform intracranial pressure.

I now began to study blood-pressure during lumbar puncture, especially with reference to the effect on injection of serum. I have now made blood-pressure readings in about 200 cases of meningitis, making from 500 to 700 lumbar punctures. I have found almost uniform results in blood-pressure-change on injecting serum, and have applied those changes as a guide to the quantity of serum that could safely be injected. The blood-pressure-change was also frequently a guide, indicating the quantity of fluid that could be withdrawn safely. In a later paper I shall refer in detail to Robinson's work<sup>1</sup> on blood-pressure in meningitis, and to Cushing's<sup>2</sup> studies on the relationship of blood-pressure to change in intracranial pressure.

The effect on the blood-pressure is inconstant on withdrawing fluid by lumbar puncture in meningitis; most often there is a drop in blood-pressure, occasionally quite large, especially on withdrawal of large quantities of fluid. My ordinary procedure in an adult case, beginning with an average blood-pressure of 110 mm. of mercury, is to stop the further withdrawal of fluid if there is a moderate drop in blood-pressure, for example of 10 mm. of mercury; in children, of 5 mm. Occasionally the blood-pressure begins to drop very quickly as soon as the removal of fluid is begun; the blood-pressure then is a guide indicating how rapidly or slowly the fluid may be withdrawn. In other cases there is no change in blood-pressure, or there may even be a rise, on removing fluid; one can withdraw as much fluid as possible, usually till the cerebrospinal fluid pressure is normal, this being roughly measured by counting the drops of fluid as they flow from the needle; one drop of fluid every three to five seconds corresponds roughly to a normal pressure.

After withdrawal of a suitable quantity of cerebrospinal fluid, the serum is ready to be injected. As usual, the serum is warmed to body temperature and then injected slowly, either by the gravity method or by syringe. I much prefer the gravity method of injecting the serum; it has many advantages and few of the disadvantages of the syringe method. As a rule, as soon as the injection of serum is begun, the blood-pressure drops and continues to drop steadily. Reasoning by the old method of injecting serum, one would expect a rise in blood-pressure; this, however, is rarely the case. As

stated, in the great majority of cases when the injection of serum into the subarachnoid space is begun, the blood-pressure drops and continues dropping steadily as the larger quantity of serum is injected; after there has been a material drop, for example, of 20 to 30 mm. of mercury, the blood-pressure begins to drop relatively much faster if more serum is injected. Thus if an injection of 15 c.c. of serum causes a drop of 20 mm. of mercury in blood-pressure, injecting only a few more cubic centimeters of serum may cause a sudden drop of 40 more mm. of mercury, making a total drop of 60 mm. or more. In one robust adult whom I treated, there was a drop of 30 mm. of mercury after injecting only 12 c.c. of serum. His was a very severe case, and I wished to introduce as much serum as possible; I injected 3 c.c. more, making a total of 15 c.c. of serum. His blood-pressure, at one bound, dropped 30 mm. more, making a total drop of 60 mm. His clinical signs at this time did not indicate shock; the pulse was fair; the color was good, but rapid, but breathing was shallow and a little irregular. I decided, however, to watch him for a time. A few minutes later he suddenly stopped breathing, then his heart stopped. Immediate active treatment, which I shall indicate later, gave immediate response. It is easy to see how these patients who have had a large drop in blood-pressure, with not much other evidence of shock, may thus suddenly succumb either during or after the injection.

My usual technic in the operation of administering serum is to have one assistant take blood-pressure readings throughout the whole operation. If the blood-pressure drops during the removal of cerebrospinal fluid, I use it as a guide indicating when to stop withdrawing fluid. I accept, as a rule, the arbitrary drop of 10 mm. of mercury. I use the blood-pressure as an absolute guide, indicating the quantity of serum that I can safely inject; here it is also a guide as to how quickly the serum may be injected. As a rule, very rapid injection under considerable force will cause a greater drop in blood-pressure. By the gravity method the serum is allowed to run in slowly by gravity, the funnel being raised or lowered to regulate the flow. The barrel of a 10 to 15 c.c. antitoxin syringe may be used as the funnel, attached to about 12 inches of rubber tubing about one-quarter inch in diameter. Ten minutes is a good average time to allow for the fluid to run in, though I have frequently taken twenty minutes or longer, especially in cases beginning with a low blood-pressure, or when the blood-pressure dropped very quickly. It is much harder to control the rate of injection by the syringe method and one may accidentally use too much force in injecting. I have found that a total drop of 20 mm. of mercury in an adult with average blood-pressure of 110 to 120 mm. of mercury is a safe indication to stop the further injection of serum. Occasionally there is an initial rise in blood-pressure after the injection of a few cubic centimeters of serum, followed by a subsequent drop as larger quantities of serum are injected. Very rarely the blood-pressure shows a material rise after the injection of serum.

Since I began using this method, the average dose of serum that I have used has been considerably smaller; frequently not more than 15 c.c., averaging 20 to 25 c.c. in adults and in proportion in children. When the blood-pressure has allowed, I have injected larger quantities also, 30 to 40 c.c., very rarely more. Judging by the good results with the smaller doses of serum, I believe that it is very rarely necessary or beneficial to inject more than the maximum of 40 c.c. of serum. The

1. Ayer: *Clinical Laboratory Bull.* No. vi, November, 1910.

2. Cushing: *Bull. Johns Hopkins Hosp.*, 1901, xii, 290.

method is of great benefit not only in the average case, but also in the atypical and difficult one; thus in cases with thick plastic exudate, when the fluid will not flow through the needle, it is a beautiful guide, absolutely indicating how much serum one can inject safely under pressure; similarly, in cases with little exudate, in which one introduces a larger quantity of serum than the cerebrospinal fluid withdrawn. If the fluid be injected into the subarachnoid space, under wrong diagnosis, in cases with posterior basic meningitis, the drop in blood-pressure will be very large after injecting only a few cubic centimeters. The blood-pressure is also a guide in injecting serum directly into the ventricles, in cases of posterior basic meningitis.

What clinical symptoms are associated with the drop in blood-pressure? In the order of their appearance these are: Stupor, which deepens more and more as the blood-pressure falls; respiration becomes superficial and irregular, at times deep, stertorous, slow and irregular; with a large drop in blood-pressure, breathing may stop suddenly; pulse will often continue good, even with a large drop in blood-pressure, and even with marked change in the breathing; at times the pulse becomes slow and irregular; the pulse therefore, is very often misleading; the pupils dilate, increasing with the greater drop; incontinence of feces and urine occurring during a lumbar puncture usually accompanies a drop in blood-pressure, and is a warning.

What is the immediate treatment for severe symptoms during or after the injection of serum? As already indicated, with a material drop in blood-pressure, further injection of serum should be stopped. If, however, the blood-pressure suddenly drops very much, possibly accompanied by the above-mentioned symptoms, the indication is immediately to remove fluid from the canal; if one uses the gravity method for injecting, this is easily done by lowering the funnel; in bad cases in which the breathing stops, as much fluid as possible should be removed and active artificial respiration begun. Epinephrin in large doses by intramuscular injection, and other vasomotor stimulants, and atropin help. Even with severe symptoms, if these measures be applied immediately and actively, the patient usually responds.

What effect has epinephrin administered by intramuscular injection, before the puncture in preventing the symptoms mentioned? Epinephrin administered before the puncture will tend to prevent the large drop in blood-pressure on injecting serum. I prefer not to use epinephrin in this way except in cases with initial low blood-pressure.

In reference to the use of general anesthetics during the operation, I shall say here, briefly, that in my experience general anesthesia is dangerous, and that it should be used only where absolutely necessary in violent patients. During the administration of an anesthetic the blood-pressure is a comforting guide. I have found that giving many patients water through a straw will keep them quiet; even delirious adults will reflexly suck on the straw and quickly become quiet. During the operation the patient will sometimes drink as much as nine or ten glasses of water. It acts especially well with children; I have referred to it as "water anesthesia."

I am now tabulating my results, since I have used the blood-pressure method in treatment. Most of the cases were studied in the present Texas epidemic. The results were extremely good. The general reaction following the injections was usually not as severe as formerly; temperature did not rise as much; the patient was usually

more comfortable and the general condition better. The dose of serum, as stated, was much smaller; very young children about or under one year especially, at times could not bear more than 2 to 3 or 4 c.c. of serum and, in a number of cases, responded wonderfully well. In 185 cases, roughly tabulated, the total mortality was 25 per cent., this including many patients who were brought to the hospital in very bad condition. A number were brought in during the very last stages, and some were brought in from a distance of up to a hundred miles; others, with pulmonary edema, who died a few minutes later. Excluding these apparently hopeless cases in which the patients died in from a few minutes to twenty-four hours after admission, the mortality was about 10 per cent. The cases considered hopeless were marked so on the chart immediately on admission.

Most of the meningitis cases studied were in adults; many patients were past middle age; they included negroes and whites. The mortality was highest among negroes; they seemed to offer little resistance, and easily developed bronchopneumonia. In children the mortality after exclusion of apparently hopeless cases was roughly about 5 to 6 per cent., among them a number being below 1 year of age. There were also about seven cases of posterior basic meningitis on the list.

#### CONCLUSIONS

1. The old method of administering serum is inaccurate and sometimes dangerous.
2. Blood-pressure change is a very accurate guide to the quantity of serum that can be safely injected, frequently also indicating the quantity of cerebrospinal fluid that can be withdrawn.
3. The average dose of serum as controlled by blood-pressure is smaller than by the old method.
4. Following an injection of serum, controlled by blood-pressure, the after-effects are usually much less severe.

Mortality figures which will be accurately tabulated later show unusually good results.

I desire to express my thanks to Dr. A. W. Nash, city health officer of Dallas, Tex., with whom I studied the cases in the City Hospital, Dallas, for his courtesy in allowing me to use the hospital records, and for his very valuable cooperation in the studies.

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**What the Doctors Have Done.**—"Now and then someone abuses the medical profession, and often the funny man springs a joke at the expense of the doctor, but for all that," remarks the *Herald*, Palestine, Tex., "he is a crusader whose work needs no boasting and whose ministrations have been of inestimable value to the world and to mankind. The laity appreciate him most and understand him best as a combater of epidemics and contagious diseases. And his work has been little less than marvelous. To begin with, the discovery of all ethical doctors is based on an obligation that as soon as he has found a remedy, a preventive or cure for disease, he must give it to the world and to the profession without reserve and without cost. And through his research and sacrifice the dread of small-pox has been almost eliminated, whereas a few short years ago people went into hysterics at its name. And yellow fever has been almost eliminated from the face of the earth. And even the dreaded typhoid fever has yielded some of its horrors to his wisdom and treatment. And now he turns his attention to the latest contagion to disturb the happiness of this people, meningitis, and he will in time conquer that. A good doctor is a necessity to mankind, while a crook in the profession is a disgrace to humanity."