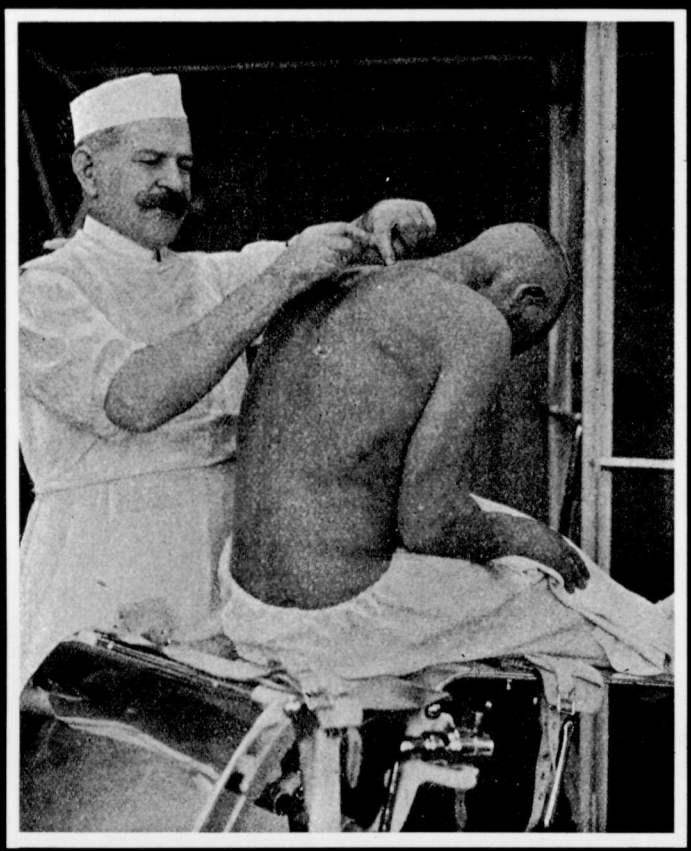
The History of Anesthesiology

Reprint Series: Part Three



Professor Thomas Jonnesco performing his much touted total spinal anesthesia

SPINAL ANESTHESIA

Spinal Anesthesia, like many discoveries had many contributors, but our list of important clinical applications includes:

Tait and Caglieri's *Experimental and Clinical Notes on the Subarachnoid Space.* This first successful use of spinal anesthesia in the U.S. was performed in San Francisco, California on October 26, 1899.

Rudolph Matas' *Intraspinal Cocainization* was the first published account of a successful spinal performed on November 10, 1899.

Thomas Jonnesco's *Remarks on General Spinal Analgesia* is included as an example of how one's enthusiasm for his own technique can often exceed his discretion.

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EXPERIMENTAL AND CLINICAL NOTES ON THE SUB-ARACHNOID SPACE.

By DRS. DUDLEY TAIT and GUIDO CAGLIERI.

SAN FRANCISCO, CAL.

From the exclusive domain of anatomy and physiology, the meningeal route has made its way, through the work of clinicians, to the sphere of practical medicine and surgery. To Quincke is due the credit of having demonstrated the innocuousness of sub-arachnoid lumbar puncture, its facility of execution and the harmlessness of the withdrawal of a considerable amount of cerebro-spinal fluid. Soon after Quincke made his original communication concerning "lumbar puncture," scores of physicians, in their enthusiasm for this new mode of relieving intra-dural pressure, predicted the curability of many diseases of the cerebro-spinal system, previously deemed hopeless. In epilepsy, tuberculous meningitis, and general paralysis, many expected wonderful results. The German school, for example, singularly oblivious to the diffuse and deep cellular lesions present in tuberculosis of the meninges, the best-known of all meningeal infections, adopted lumbar puncture as a logical and valuable therapeutic measure. A few doubtful cases of temporary amelioration in tuberculous meningitis were first reported. Then followed a long series of dismal failures. To-day no one seriously contends that meningitis, especially of the tuberculous variety, can be cured by simply relieving pressure, décompression; and when we recall the extent of the bacillary lesions, the constant morbid changes in the nerve tissue,

cerebral and medullary, subjacent to the meninges, and particularly when we consider the anatomy of the sub-arachnoid space, it seems almost incomprehensible that eminent surgeons in Europe and America should propose drainage of the lateral ventricles as a means of combating tuberculous meningitis. This procedure, first suggested by Wernicke (1881) and Zenner (1886), and adopted later by Von Bergmann (1887), Keen (1888), and others, is not in accordance with either the clinical or the pathologic findings, as it is well established that the softening noted post mortem in cases of tuberculous meningitis is principally due to an inflammatory process, and not to increased intra-ventricular pressure, which in reality plays a secondary part in the production of coma, and failing of the cardio-respiratory action. Some physicians have argued from the analogy of tuberculous meningitis to tuberculous peritonitis, that drainage ought to do good in the former condition as it does in the latter. These authorities forget that the lesions under discussion are very different, and that consequently there is no analogy to guide us.

In the present communication we did not deem it necessary to review the subject from an historic or biographic standpoint, except to establish beyond possible controversy the question of priority in cocain analgesia by the spinal route. To an American, J. Leonard Corning,* belongs the credit of having first suggested and carried out, both in animals and upon the human subject, spinal analgesia by means of cocain

*Intradermic infiltration of cocain was used by Reclus in several hundred operations, minor and capital, before Schleich advocated this method of analgesia.

The method of cocainization, known in Europe as Kummer's, in which the field of operation is shut off by means of an elastic band, was made known and used by Corning as early as 1884. E. Hoffman, (Deut. med Woch. 1886,) attributed "the essential advancement in the application of cocain for local anesthetic purposes to Corning's discovery."

Harvey Cushing (Annals of Surgery, January, 1900,) erroneously states that Corning introduced cocainization of main nerve trunks. This method was the result of experiments, made in 1886, by Feinberg, Kochs and U. Mosso. Krugius of Helsingfors, after whom the method is named, was the first (1894) to make use of these experiments. Cushing's error is probably due to the fact that Koch's work was reviewed in N. Y. Med. Journal, January 22, 1897, by Corning.

injected into the lower dorsal region. Corning reported his experiments, October 31, 1885, to the New York *Medical Journal*. Although his reasoning was manifestly unsound regarding the mode of action of the analgesic substance, he, nevertheless, succeeded in obtaining analgesia of the lower limbs, scrotum, penis and lumbar regions, both in the dog and upon man. Corning also mentioned the possibilities of this method of analgesia in genito-urinary and other branches of surgery.

Ziemssen (1893) was the first to suggest injections of diverse medicaments by means of lumbar puncture. Sicard was the first, however, to carry out this plan. This clever investigator began his studies in this domain as early as 1897. His first communication to the biological society of Paris was made in April, 1898, whereas Jacob, working in the laboratory of Prof. Leyden, of Berlin, published his first report a month later. Sicard was also the first to use tetanus antitoxin and saline solution in the sub-arachnoid space. While great credit is unquestionably due Bier for calling attention to the analgesic properties of cocain by lumbar puncture, it should be remembered that his work comprised little more than the perfecting of Corning's technic, in accordance with Sicard's experimental studies. Councilman, Mallory, and Wright (1898), of Boston, in their remarkable report on cerebro-spinal meningitis, were among the first to utilize the sub-arachnoid space for the bacteriologic study of meningeal infections.

The review of general literature shows that all are agreed on the diagnostic value of the study of cerebro-spinal fluid. It is indispensable in cases of meningitis, and may render valuable assistance in the differentiation of cerebral lesions and neoplasms, and was well illustrated by a case of cerebral actinomycosis correctly diagnosed by Monod and Sicard. In tuberculous meningitis, especially in circumscribed tubercles, the bacillus is found, by lumbar puncture, in 25 per cent of the cases, according to the statistics of Leuhartz and Stadelmann.

The present communication is but a resumé of the work which has engaged our attention during several months. In the study of the sub-arachnoid space we have endeavored to elucidate certain doubtful points, and have sought to make some practical deductions therefrom.

The sub-arachnoid space may be reached by several routes:

1. By trephining the skull.
2. The atlo-occipital route followed by Magendie in the demonstration of the constant presence of cerebro-spinal fluid.
3. The dorsal route, with or without laminectomy.
4. The sacro-lumbar route.
5. Through the central spinal canal.

The second, third and fifth routes are seldom used, on account of the difficulty and danger encountered. In six out of seven cadavers we found the dorsal route accessible as high as the sixth space, without preliminary laminectomy.

6. The cervical route.

We found the sixth cervical space a sure and extremely easy route in the human being. We first tried this route on the cadaver, by injecting colored fluids, without previously having incised the skin, and obtained uniformly satisfactory results.

The route most commonly adopted is the lumbar or sacro-lumbar. We find the latter preferable in animals, and the third lumbar space the most practical in the human being. The technic of lumbar puncture is well known, and is usually described in text-books. We desire, nevertheless, to call attention to a few points of interest, if not of value.

1. The distance to be traversed by the point of the needle is generally given as 7 to 8 cm. We have never found the latter figure, even in obese patients, but most invariably 6½ to 7 cm. In two cases of adults the distance was 5½ cm.

2. The smaller the caliber of the needle, the slower, and therefore the safer the procedure. The rapid introduction of 2 cc. of liquid, in one of our cases produced considerable shock.

3. By first withdrawing a small amount of cerebro-spinal fluid, one is certain of making the injection within the canal.

4. Slow aspiration of the fluid, contrary to the opinion of German authorities, does not induce any untoward symptoms.

5. Lumbar puncture may be rendered painless, and extremely easy, by injecting a few drops of Schleich's mixture into the skin and subjacent soft parts. By this simple plan, the sudden start of the patient will be prevented, and the relations of the osseous parts will thus remain undisturbed.

CEREBRO-SPINAL FLUID.

In this part of our investigations, a large number of animals, guinea pigs, rabbits, cats, dogs, and even horses, were used for experimental purposes, and a series of cadavers served to acquaint us with the intricacies of the sub-arachnoid space. Whenever feasible, the technic adopted in animals was as near as possible that followed in the human being: without preliminary laminectomy. Several patients subjected to lumbar puncture for therapeutic purposes were utilized to clear up doubtful points relating to the physiology of the sub-arachnoid space, and furnished valuable data. The cerebro-spinal fluid resembles no other organic fluid. Our knowledge of its origin and mode of secretion and resorption is very incomplete. Anatomists compare the sub-arachnoid space to a serous cavity, to an immense lymph sac into which empty the cerebro-spinal perivascular lymphatic vessels. Hence the important role ascribed to the lymphatics in the evolution of infectious meningitis. Against this classical opinion may be cited a long series of facts which compel us to change most radically our conception of the cerebro-spinal fluid, its nature and role in the various infections. The normal cerebro-spinal

fluid possesses none of the chemical properties of lymph. It contains no histological elements, no albumin, no leucocytes, no red corpuscles, no fibrigenous factors, or fibrin ferment. In only one of our cases, which had been previously subjected to an injection of iodid of potassium, we found a few leucocytes. Widal and Sicard demonstrated that in the course of typhoid infection or immunization, the cerebro-spinal fluid does not possess agglutinating and preventive properties, in contradistinction to the secretions of serous membranes, (peritoneum, pleura). Sicard showed that, unlike blood, the cerebro-spinal fluid does not coagulate the non-spontaneously coagulating organic liquids, hydrocele fluid, for example. It is an excellent medium for the preservation of leucocytes, the latter retaining their amoeboid movements and chemotaxic properties. It only dissolves the red corpuscles after considerable time, in vitro. Artificial medicinal increase of arterial pressure does not augment the secretion of cerebro-spinal fluid. On the contrary, direct increase of pressure by intra-venous injection of saline solution, produces a noticeable increase, as the following experiment goes to prove:

Experiment I, dog, 20 kilos. Fine needle introduced in the lumbar sub-arachnoid space. After 10 cc. have escaped, the fluid flows very slowly (one drop every two seconds); 200 cc. of salt solution are then injected into the femoral vein. The flow of cerebro-spinal fluid shows an increase within ten minutes.

In a series of patients we made lumbar punctures after having given, by mouth or sub-cutaneously, repeated doses of salicylates, antipyrin, cyanid of mercury and potassium iodid, and in no case was the drug found in the cerebro-spinal fluid; whereas, on the contrary, urinary analysis gave invariably a positive result.

Experiment II, dog, 15 kilos. Intra-venous injection of 5 cc. of 1 per cent solution of mercuric cyanid caused death

within three minutes. Even under these exceptionable circumstances the cerebro-spinal fluid showed no trace of the toxic substance.

Another interesting fact is that absorption and elimination occur when chemical substances are injected directly into the sub-arachnoid space. This was confirmed by experiments in animals and also in our work on man. These facts prove conclusively that the osmotic current exists in only one direction; *There is exosmosis, but no endosmosis.* (Sicard).

Considerable knowledge may be derived from the careful study of the mode of diffusion of the cerebro-spinal fluid, under various conditions. In our work we employed insoluble colored mixtures which enabled us to note with accuracy and facility both the microscopic and the macroscopic results in the different regions involved.

Briefly stated, the plan pursued was as follows: After having located accurately the various landmarks, a fine needle was introduced into the sub-arachnoid space of the lumbar region, and a mixture of carmin and saline solution, or a dilution of common washing blue, ferro and ferri cyanid, injected in variable quantities, with or without pressure, according to the object of the experiment. The results were as follows.

When injected without pressure, the colored fluid stains the space at the point of injection, and then diffuses in all directions, ascending and descending, following the meningeal prolongations along the spinal nerves, to the intervertebral foramina, where it stops abruptly. The extent and rapidity of diffusion are influenced by several factors: the amount, composition, density of the liquid, and principally the pressure under which the liquid is injected. A slow injection of 1 cc. of the blue mixture, in a rabbit weighing 900 grms., ascends rapidly, and if the animal be killed after ten hours, the colored fluid will be found around the medulla oblongata, and at the base of the brain.

If the same amount of colored fluid be injected under considerable pressure, and the animal sacrificed after twenty-four hours, the fluid will be found over a much more extensive area, diffusing from the spinal sub-arachnoid space through the foramen of Magendie to the fourth ventricle, through the *iter a tertio* to the third ventricle, and finally to the cortex of the brain. We found that when 5 cc. of the colored fluid were injected under great pressure in the lumbar space, the diffusion occurred instantaneously, and the color of the animal's eye recalled, in certain cases, the substance used.

Experiments illustrating the course pursued by the fluid from the lumbar space to the cortex of the brain: Rabbit, 850 grms. Preliminary trephining of the skull in the temporal region. Injection of 10 cc. of blue mixture in the lumbar space; time occupied, three minutes. After 2 cc. had been injected, the brain bulged through the trephine opening, and finally burst, the colored fluid escaping through the rent. Death occurred four minutes later. The inverse experiment was made by injecting the fluid directly into the lateral ventricles, but has not as yet given definite results. Improved technic will undoubtedly confirm the facts noted above. Our best specimens were obtained by means of injections made under a considerable pressure, death, in some cases, ensuing during or shortly after the operation.

The necropsies of a long list of rabbits so treated showed the following conditions:

The pia-arachnoid is colored in its entire course along the cord and brain, continuing along the sheath of the auditory, facial and optic nerves, and also following the prolongations through the cribriform plate of the ethmoid. On the optic nerves the stain follows the meningeal sheath and generally stops at the junction with the sclerotic. In several of our

specimens, however, the colored material followed a course similar, inversely, to that of the diplococcus in some cases of cerebro-spinal meningitis, i. e., involved the sclerotic, choroid, papilla and retina. We have never found the cornea stained. Microscopic sections of brain and cord show the course followed by the colored fluid and its relations to the perivascular sheath. In several of the forced injections the colored fluid was found in the lungs, and from numerous necropsies we satisfied ourselves that it had escaped from the sub-arachnoid space through the blood stream, thus invalidating the views of Foster, who describes the escape of cerebro-spinal fluid as occurring along the tubular prolongations of the pial membranes that accompany the cranial and spinal nerves to the general lymphatics.

The study of the numerous specimens mentioned above is of considerable interest in reference to the origin and evolution of meningeal infections. For instance, they explain very lucidly how tubercle bacilli, which are so frequently found in the tonsils, adenoids and nose, may easily reach the sub-arachnoid space, independently of the lymphatics, through the cribriform plate of the ethmoid, or the aqueductus Fallopii. The part played by the cerebro-spinal fluid in the dissemination of the agent of infection is also made very clear. The same observation holds good in regard to infective lesions involving the cavities contiguous to the sub-arachnoid space, eye and ear. Another fact of great pathological importance noted by Sicard is the insignificant role of the lymphatics in the origin of meningeal infections. As Sicard remarks, it is difficult to understand by what process the tubercle bacillus, escaping from a cervical or mediastinal gland can follow a retrograde course to the cerebral perivascular lymphatics. On the contrary, infections of hematogenous origin can easily occur, as Sicard's cases prove conclusively.

EXPERIMENTAL THERAPEUTICS AND PRACTICAL DEDUCTIONS.

The action of a drug varies with the route through which it is introduced into the body. Without apparent effect, or harmless, when given by mouth or subcutaneously, some substances, chemical or microbic, administered in like doses by the intra-venous route, produce serious or even fatal effects. The intra-cerebral route, as was well illustrated by the interesting studies of Roux and Borel, and by Lesné and Sicard, requires a smaller dose to produce a fatal effect than any other route. The sub-arachnoid route occupies a position midway between the intra-cerebral and the intra-venous routes (Sicard).

The difference in action of drugs, according to the route employed, cannot be ascribed entirely to the degree of rapidity of its absorption and elimination. The tissue involved plays an undoubtedly important part. Each tissue reacts in a distinct manner. In regard to the brain, it has been suggested that the compression and traumatism incidental to the intra-cerebral injections may explain, in part, the difference in effect, but Widal, Lesné and Sicard have proved that large quantities of saline solution can be injected into the brain without causing damage. Furthermore, intra-cerebral injections of tetanus antitoxin have proved to be harmless and non-productive of appreciable lesions. These assertions were fully verified in the necropsy of a case which we reported recently at the California Academy of Medicine.

In the following notes we relate our experience, in animals and the human being, with the sub-arachnoid space viewed as a therapeutic route:

We sought to determine the degree of tolerance of this space for various toxic and non-toxic substances, some of which had not been used heretofore by this route, and to ascertain the action of said substances on the subjacent normal or pathologic nerve tissue.

In animals the drugs used were cocain, iodid of potassium and cyanid of mercury.

Cocain: Dog, 10 kilos. Injected in lumbar space 1 cc. of 1 per cent solution of cocain. Within three minutes, analgesia was noted on lower limbs. At the expiration of five minutes, complete analgesia, superficial and deep, was detected over the entire surface of the body, ears, nose and mouth. The animal presented a semi-paretic condition of the hind legs for thirty minutes and then ran about as usual. Duration of analgesia was one hour and ten minutes.

Dog, 32 kilos. Injected rapidly in the lumbar space 2½ cc. of 1 per cent solution of cocain. Three minutes later analgesia was noted over entire body, as in the previous experiment. The animal was greatly depressed, vomited and was paralyzed in the hind legs. The paralytic condition ceased after the second day.

Mercury cyanid: Dog, 9 kilos. Injected 2 cc. of 1 per cent solution. No pain was noted; mild paraplegia lasted fifteen minutes.

Iodid of potassium: Our experiments with this drug were made with doses too small for any local effect. We found, however, that to be of practical use by lumbar puncture, iodid of potassium must be considerably diluted. The saturated solution invariably produced most intense and prolonged pain.

INJECTIONS IN THE HUMAN BEING.

By the cervical route. Remembering the inocuousness of intra-cerebral injections, and judging from the results of a series of punctures of the cord in animals, we inferred that the slight traumatism produced, in some cases by the needle, would not be followed by any untoward symptoms.

A. C., aged 49, very painful chronic gonorrheal arthritis of the left knee and right wrist. Injected 1½ cc. of 1 per cent solution of cocain in the sixth cervical space, at a point

1½ cm. from the median line. Eight minutes later, analgesia was noted from the toes to the level of the thyroid. On the limbs the analgesia was both superficial and deep. We were thus able to manipulate both of the diseased joints without inducing pain. Analgesia ceased within eight minutes.

A. L., aged 42, rectal fistula and axillary adenitis. Injected 1 cc. of 1½ per cent solution of cocain in the sixth cervical space. Fifteen minutes later we noticed very slight analgesia extending over the chest. This disappeared within five minutes. In neither of these two cases were there any disagreeable consequences. The procedure was painless. The second patient walked a mile thirty minutes afterwards.

Third case, same patient as in second case. Injected in the sixth cervical space 3½ cc. of ½ per cent solution of cocain. Patient complained of a sharp pain in the left arm during the introduction of the needle. Cephalalgia and feeling of intense heat over entire body, with copious perspiration and slight vomiting were almost immediately noticed. The pulse, temperature, respiration, and pupils remained unchanged. No analgesia, even after one hour and twenty-five minutes. Patient then walked home one mile. The following day, he complained of slight headache and weakness in the legs. Upon the third day his condition was normal.

All of these patients have been examined weeks after the injection and found free from any possible complication.

By the lumbar route :

I. T., aged 43, syphilitic myelitis. Injected $\frac{8}{10}$ cc. of saturated solution of iodid of potassium, after having withdrawn 1 cc. of cerebro-spinal fluid. Intense pain and burning were experienced immediately in both feet. Shortly afterwards these symptoms were noted in the thighs, and the patient urinated involuntarily. The painful phenomenon lasted six hours. The same patient subsequently received, by lumbar puncture, an injection of 3 cc. of 1 per cent solution of cyanid

of mercury. Nothing was noted until the fifth hour which ushered in numbnesss and tingling of the lower limbs. Five hours later patient had a gastric crisis, of greater severity than ever before. No apparent amelioration resulted from the injection in this case. The gastric crises are more frequent than formerly.

Sub-arachnoid injections of cocain were made in a series of cases requiring surgical intervention.

M. D., aged 54, necrosis of tibia. October 26, 1899, injected 1 cc. of ¾ per cent solution of cocain. No analgesia was noted before thirty-five minutes. Analgesia, both superficial and deep, was then well marked in the lower limbs. Osteectomy of tibia was performed without causing either pain or discomfort. No unpleasant after effects. Analgesia ceased after forty minutes.

O. L., pelvirectal fistula. Injected 1 cc. of ½ per cent solution of cocain. No analgesia followed. Two hours later patient complained of tingling and numbness in the legs. Investigation showed that the cocain solution was very old, and had been boiled many times.

M. M., aged 26. Acute osteo-myelitis of the tibia. Injected 1 cc. of 1 per cent solution of cocain. Analgesia first noted after twenty-five minutes. Patient also lost muscular sense in the lower limbs. Amputation was made through the condyles after a thorough exploration of the knee joint. No pain noticed except when the popliteal nerve was pinched. The patient then said he felt the instrument, but did not complain. Duration of operation thirty minutes. No after effects. Analgesia lasted fifty-five minutes.

M. U., aged 32. Urethral fistula, membranous portion; injected 1½ cc. of 1½ per cent solution of cocain after having withdrawn 5 cc. of cerebro-spinal fluid. No analgesia was noted. The solution used in this case was not fresh, and had been boiled by mistake for thirty minutes.

M. L., aged 48. Sarcoma of uterus. Injected 1½ cc. of 1 per cent solution of cocain, after having withdrawn 1 cc. of liquid. Analgesia of the right leg was noted after eighteen minutes, and of both legs after twenty-five minutes. No analgesia of the clitoris after thirty minutes, when vaginal hysterectomy was made. Vaginal incision with Paquelin cautery was painless. Traction upon the broad ligaments caused very slight pain. Section of the broad ligaments and extraction of the left ovary proved painless. The pressure of the clamps was not noticed by the patient during or after the operation; duration of operation was twenty minutes. The analgesia had then extended as high as the clavicles; the patient neither felt the puncture for hyperdomoclysis nor was discommoded in the least by the consequent distension. Patient complained of the noise of the instruments. No unpleasant after effects. Analgesia lasted one hour and ten minutes. Patient had her usual liquid diet during the same afternoon. Clamps removed after forty-eight hours.

M. N., aged 40. Tuberculous knee. Injected 1½ cc. of 1 per cent solution of cocain, after having withdrawn 3 cc. of fluid. Analgesia was noted in both legs after twelve minutes. Usual transverse incision for resection of the knee. The condition revealed, by a most thorough exploration of the bones and soft parts, contra-indicated resection; consequently the wound was closed and the patient informed of the necessity of an amputation. No pain noted at any time during the operation, which lasted fifteen minutes. Duration of analgesia was one hour and five minutes. The patient complained of slight nausea shortly afterwards, but this ceased rapidly. Patient died two and a half months later, of general tuberculosis. Necropsy showed normal cord and meninges in the lumbar region.

M. M., aged 26. Inguinal hernia. Injected 2 cc. of ½ per cent solution of cocain; five minutes later analgesia was

noted on both legs. The operation, a modified Bassini, was begun one minute later. The skin incision was painless, but some discomfort was noticed during the incision of the fascia of the oblique and the dissection of the sac from the cord. The patient was rendered nervous by the noise of the instruments. The resection of 15 cm. of omentum was painless. The upper part of the deep layer of sutures caused some pain, but the lower part proved almost painless. The suturing of the skin was not altogether painless. No troublesome after effects. In this case the cocain was diluted with the intention of increasing its diffusion; the solution was, evidently, too weak.

M. L. Necrosis of tibia. Injected 1½ cc. of 1 per cent solution of cocain after having withdrawn 1½ cc. cerebro-spinal fluid; analgesia noted after five minutes; exploration and curetting begun immediately; no pain experienced; no after effects. This patient had collapsed under chloroform and also under ether anesthesia upon former occasions.

We have endeavored to apply sub-arachnoid injections of cocain to obstetrics, but we reserve this part of our work for further study. In the study of cocain we found that its local action was in an inverse proportion to its degree of dilution, and that the diffusibility increased in proportion to the amount of the liquid injected. Our experience teaches us that the disagreeable after-effects of sub-arachnoid injections of cocain are, in part, due to the sudden increase of pressure, and may be avoided by the preliminary extraction of a small amount of fluid, and by making the injection slowly. The amount of cocain is also a factor of importance. With more than 1½ cc. of 1 per cent solution, or more than 1 cc. of 1½ per cent solution of cocain, we generally noted nausea, headache and weakness. Toxic symptoms occur in the sub-arachnoid method in very much the same manner as in the intradermic method of cocainization. In the search for substances less toxic than cocain, we considered eucain and nirvanin. The former, in

animals, seemed to differ but little from cocain. Nirvanin, even in a 5 per cent solution, used sub-cutaneously, proved less toxic than cocain, but only slightly diffusible. The analgesia induced is less pronounced and disappears more rapidly than that caused by cocain. Schleich's mixture is valueless for sub-arachnoid use.

CONCLUSIONS.

1. To the already known practical routes leading to the sub-arachnoid space, we propose to add the "low cervical," in the sixth cervical space, which we find both easy and safe.

2. The cerebro-spinal fluid possesses none of the properties of lymph.

3. Contrary to the classical opinion, the cerebral perivascular lymphatic sheaths do not empty into the sub-arachnoid space. (Sicard).

4. Liquids injected by lumbar puncture diffuse rapidly toward the different cavities of the brain and subsequently reach the cortex.

5. The difference in osmotic currents in the cerebro-spinal fluid, presence of exosmosis and absence of endomosis, in addition to the protection afforded by the perivascular lymphatic sheaths, explains the rarity of infection of the cerebro-spinal fluid in the course of generalized blood infections and also the gravity of primary infections of the cerebro-spinal fluid. (Sicard).

6. Direct intra-medullary medication is feasible and deserving of further trial.

7. Sub-arachnoid injections of cocain are devoid of danger if made with certain precautions. The solution should be freshly prepared and injected slowly at a temperature of 37 degrees C, and never in a greater quantity than 3 cc.

8. The extent and duration of the analgesia thus induced are generally in direct proportion to the amount of drug injected. Analgesia is noted in some cases as early as

five minutes after the injection, and in others, for unknown reasons, as late as thirty-five minutes. Its duration is sufficient for the performance of all operations on the lower limbs and pelvis and may be of service in obstetrics.

9. The disagreeable effects sometimes noted after these injections, headache, vomiting, are partly due to the sudden increase of pressure in the sub-arachnoid space, too rapid diffusion toward the brain, and principally to the amount of cocain used. These post-operative symptoms are never alarming or lasting. They recall the effects of intradermic injections of cocain and never resemble in severity the symptoms so frequently observed during and after chloroform or ether anesthesia.

10. One cubic centimeter of a one per cent solution of cocain, injected slowly, is generally sufficient for all practical purposes, and has not been followed by untoward symptoms.

11. For obvious reasons it is a good plan to withdraw a small amount of cerebro-spinal fluid prior to making an injection.

12. To the careful surgeon who aims to gradually divorce himself from the dangers of general anesthesia and the limitations of superficial analgesia, spinal analgesia may, under certain exceptional conditions, prove of signal service, and it behooves us to herald abroad the fact that this progressive step was made by a modest American surgeon, J. Leonard Corning.

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DISCUSSION.

Dr. K. Pischel, said: I would like to ask Dr. Tait whether the colored fluid entered into the intervaginal space of the optic nerves?

Dr. F. D. Tait, said, in closing: In several of our experiments made under pressure, the colored fluid was found to follow the sheaths along the cranial nerves, and in exceptional conditions we found it in the choroid and retina, but never in the cornea.

THE JOURNAL

OF THE

American Medical Association

A MEDICAL JOURNAL CONTAINING THE

OFFICIAL RECORD OF THE PROCEEDINGS OF THE ASSOCIATION, AND THE PAPERS READ AT THE ANNUAL MEETING, IN THE SEVERAL SECTIONS, TOGETHER WITH THE

MEDICAL LITERATURE OF THE PERIOD

EDITED FOR THE ASSOCIATION UNDER THE DIRECTION OF THE BOARD OF TRUSTEES

BY

GEORGE H. SIMMONS, A.M., M.D.

VOLUME XXXIII

JULY—DECEMBER

1899

CHICAGO
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1899

New York City.

AS THE result of a collision between an electric car and an ambulance belonging to Harlem Hospital, two physicians, the driver and a patient are suffering from severe injuries. The ambulance was demolished.

Philadelphia.

THE J. B. LIPPINCOTT CO., whose entire plant, except perhaps the plates, was recently destroyed by fire, at once opened offices at 624 Chestnut Street, this city, and arrangements are being made for a new manufacturing building, to be occupied during the reconstruction of their former premises.

Baltimore.

A MOTION was made in the supreme court, on the 18th, for a new trial in the case of Dr. George C. Worthington, convicted October 12 for causing a death by criminal operation.

THERE were 181 deaths in this city last week, the rate per 1000 being: white, 15.61; colored, 28; average 17.39. The principal causes were: Consumption, 23; pneumonia, 18; diphtheria, 12; diseases of kidneys, 12; congestion of brain, 10; typhoid fever, 3.

Los Angeles, Cal.

HEALTH STATISTICS.

According to figures from the health officer, during the year there were 1641 deaths, or a mortality rate of 15.93 per 1000 inhabitants, using as a basis for calculation a population of 103,000. This is an increase of 40 deaths for the year over last year's total. Of these deaths, 256 occurred in the various hospitals; 189 in the County Hospital, which received patients from the entire county. There were 33 deaths from suicide during the year, 25 males and 8 females; 21 natives of the United States, 11 foreign born, one Mongolian and one African. Deaths of children under 1 year of age numbered 132, being 17 less for this age than last year. The causes of death were: specific infectious diseases, 287; diseases of the digestive system, 137; of the respiratory system, 447; of the nervous system, 131; of the circulatory system, 163; of the genito-urinary, 113; constitutional diseases, 127; violence and accidents, 104; miscellaneous diseases, 132. Of the 1641 deaths reported, 279 were natives of this city, and 150 of the three Pacific Coast states outside of Los Angeles, leaving 1212 from other parts; 1136 had lived here less than ten years. There were 289 deaths from pulmonary consumption, divided as follows: natives of Los Angeles, 13; natives of Pacific Coast states outside of this city, 19; from other parts, 257. Of the 289 persons, 206 had lived here less than ten years. Concerning smallpox, since Dec. 1, 1898, there have been in the city, 119 cases; 2 were reported prior to the above date, during 1898. There were 64 cases of variola and 55 of varioloid; 59 had been vaccinated and 60 had not been. Some of those reported vaccinated were not successfully vaccinated. There were 22 deaths, 7 being of the most severe form of hemorrhagic smallpox. No death occurred where the person had been successfully vaccinated previous to smallpox infection; 51 patients were quarantined and treated in their own residences, numbering 22 houses; 67 were removed to the smallpox hospital from 63 houses. The disease was introduced by tramps from Danby and Arizona and New Mexico. The chief cause of the spread was the delay in reporting one case in the southern portion of the city, and the concealment of another in the most densely populated portion. Of other infectious diseases, cases were reported as follows: diphtheria, 287; scarlet fever, 64; typhoid fever, 265; measles, 339. There were 34 deaths from diphtheria during the year.

New Orleans.

INTRASPINAL COCAINIZATION.

The Bier method of intraspinal cocainization was applied successfully in the Charity Hospital, here, on December 18, by Dr. A. Matas, assisted by Drs. F. A. Larue and H. B. Gessner, and Mr. Allen, interne. The patient, an Argentine *mestizzo* of 32 years, suffering from internal hemorrhoids, ulcerated, bleeding and excessively tender, had albumin and casts in the urine. A needle having been introduced in the median line, between the fifth lumbar vertebra and the sacrum, the entrance of the needle into the canal was readily confirmed by the escape of cerebrospinal fluid. Two doses of 1 per cent. normal salt solution of cocain hydrochlorate, each 1 c.c., were injected five minutes apart. Nineteen minutes after the first, an internal hemorrhoid was clamped, a groove made around it with scissors, and a ligature applied, and, following this, the distal portion was snipped off; all of this absolutely without any pain. Another hemorrhoid was removed later. Anesthesia of the lower extremities, the penis, scrotum, and perineum, the abdominal wall, the chest and, in fact, the entire body below the neck, lessening in a degree, however, from below up, was subsequently observed. The procedure was followed by the usual chill, fever to 103.4 F., nausea, occipital headache. Prof. Matas had previously—November 10—applied the method in the case of a colored man, aged 23 years, suffering from a tuberculous knee-joint: 1 c.c. of a solution of eucain B, in two doses, was injected through a needle between the first and second lumbar vertebræ. Although the entrance into the canal was confirmed by the escape of cerebrospinal fluid, followed by the usual systemic reaction, no anesthesia was produced, the quantity of eucain being perhaps insufficient.

Minneapolis, Minn.

DR. JAMES DUNN is convalescing, after a month's illness from a septic infection.

DR. A. A. LAW, who recently returned from the Philippines with the Thirteenth Minnesota, was married last week to Miss Helen Lougee, of this city.

THE MEDICAL department of the University of Minnesota, notwithstanding its commodious buildings, is full to overflowing and the regents are asking the medical faculty how to reduce the number of students. Lengthening the course to four years, and elevating the standard of admission have been accompanied by an increased attendance. A new anatomic building has just been completed, and will be in charge of Prof. Chas. A. Erdmann, who has been recommended to the regents by the medical faculty, as successor to the late Professor Hendricks. This building is the most complete of its kind in the country, and will be devoted exclusively to the teaching of anatomy. A new clinical building has also just been finished, and is in charge of Prof. James E. Moore. The one will be devoted exclusively to the teaching of clinical medicine and surgery.

Atlanta, Ga.

DR. CHARLES BOYNTON was recently married to Miss Patillo, of Decatur, Ga.

ATLANTA has recently had a severe scare on the milk question. A number were lately made very ill, and all were found to be taking milk from the same dairyman. A specimen examined revealed tyrotoxicon. There is now on foot an endeavor to establish a central station where all the milk will be examined before it can be distributed.

THE PRESENT Board of Health, which consists of both physicians and laymen, is trying to get established the position of medical health officer for the city, the incumbent to have supervision over all contagious and infectious diseases, and charge of a central bacteriologic and chemical laboratory.

LEGISLATION IN GEORGIA.

The osteopathy bill passed almost unanimously, at the recent session of the legislature, even in the face of unanimous protestations from the physicians of the state. One member, in support of the bill, said that if this system of treatment had been in vogue at the time President Garfield was shot, the bullet would have been found and extracted, thus saving our President from an untimely grave. Georgia is now "wide open" to all fads and sects and the legitimate physician will no longer find a decent field within the bounds of the "Empire State of the South." Another bill introduced by the representative from Atlanta, at the request of all the physicians of the city, was to enact a law compelling all medical colleges in the state to adopt a four years' curriculum. The bill met with instant defeat. The Atlanta College of Physicians and Surgeons, however, will almost certain to adopt this curriculum next year. [As we go to press, we learn the governor has vetoed the osteopathy bill.—ED.]

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Remarks
ON
GENERAL SPINAL ANALGESIA.

BY
PROFESSOR **THOMAS JONNESCO**,
BUCHAREST.

AT a meeting of the German Society of Surgery in Berlin in April, 1909, Professor Bier of Berlin is reported[1] to have said that the method of general spinal analgesia described by me at the Congress of the International Society of Surgery in Brussels in September, 1908, must be rejected, and Professor Rehn of Frankfort is reported[1] to have said that experiments on animals showed that considerable danger attended such injections if made higher than the lumbar region as recommended by me.

These pronouncements, which seem to be without appeal, prove once more that the method described by myself and my assistant, Dr. Amza Jiano, was too novel and too hardy to be accepted without opposition. I have never doubted that this would be so, but the facts which I am about to state will prove the conviction that this condemnation on *a priori* grounds is mistaken, and I am firmly convinced that my new method of general spinal analgesia will in a short time be universally accepted. During the eight months subsequent to October, 1908, I used spinal analgesia in all my operations, whether performed in the university clinic, in the Coltza Hospital, or in my private practice; I have never once had recourse to anaesthesia by inhalation. In addition, my hospital colleagues have daily had recourse to this method with complete success. Dr. Canny Ryall, of London, who spent twenty days in Bucarest for the purpose of studying my method, saw it used for forty operations of various character, and afterwards used it in the clinics of Professor Doelinger, of Budapest, and Eiselsberg, of Vienna. Recently I practised it myself in the clinic of Professor Schauta, of Vienna, who was convinced of its superiority over anaesthesia by inhalation. The description of the actual method which I shall now give is founded upon this extensive experience of its use.

METHOD.

There are two essential points of novelty in the method: (1) The puncture is made at a level of the spinal column appropriate to the region to be operated upon; (2) an anaesthetic solution is used which, thanks to the addition of strychnine, is tolerated by the higher nervous centres. The selection of the anaesthetic substance to be used will be determined by the surgeon's experience or confidence in any particular drug. I prefer stovaine, which has given me excellent results, and which I know how to manage; but tropacocaine or novocain are equally efficacious, and, thanks to the addition of strychnine, equally harmless.

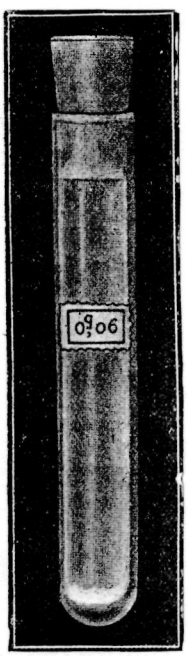

Fig. 1.

1. *The Preparation of the Solution.*

The solution must be made at the time when the operation is to be performed as follows: The necessary quantity of stovaine, tropacocaine, or novocain is introduced into a glass tube (Fig. 1) provided with an indiarubber stopper, and sterilized in the autoclave. The substances need not be sterilized since they are themselves antiseptic, and some of their properties would be destroyed by heat.

The strychnine solution is made by dissolving 5 to 10 cg. of neutral strychnine sulphate in 100 grams of sterilized (not distilled) water in a glass-stoppered bottle previously sterilized; if 5 cg. of strychnine are used, 1 c.cm. of the solution will contain $\frac{1}{2}$ mg.; if 10 cg., 1 c.cm. will contain 1 mg. The weaker solution is used for the upper, the stronger for the lower puncture. As the strychnine takes some time to dissolve, it is better to prepare this solution a little before the time when it has to be used. With an ordinary Pravaz syringe provided with a needle for lumbar puncture, 1 c.cm. of the solution of strychnine, a syringeful, is drawn up and is injected into the tube containing the dose of stovaine judged to be necessary for the puncture about to be made. The tube is corked again, and shaken, and the salts are dissolved. The same syringe is then filled with the contents of the tube, and is held with a sterilized compress and removed from the needle while the puncture is being made.

2. *The Apparatus.*

This, as has already been indicated, is very simple, and within the reach of every surgeon in all circumstances, since it consists only of a common Pravaz syringe holding 1 c.cm., and the usual needle for lumbar puncture previously sterilized by boiling. The needle I prefer has a point cut rather squarely, for since the arachnoid space is relatively small, if the point of the needle be oblique, it is possible that part of the opening might go through the dura mater while part remained outside it. If this occurs part only of the solution penetrates into the arachnoid space, while a greater or less quantity is injected into the space between the dura mater and the osseous canal, and either analgesia is not produced at all, or it is incomplete; a result too often attributed to the insufficiency of the method or the idiosyncrasy of the patient.

3. *The Puncture.*

In my communications to the Congress at Brussels and to the Academy of Medicine in Paris, I indicated four points in the spine at which the puncture should be made in order to obtain analgesia of the region to be operated upon. I had already been convinced by experience that spinal anaesthesia was not so regional as I had believed, and that medio-cervical puncture was as useless as it was dangerous. It favours the appearance of bulbar phenomena—nausea, vomiting, pallor of the face, faintness, momentary stoppage of respiration, and so on, phenomena due to a too direct action of the anaesthetic fluid upon the bulb. Their occurrence may be avoided by making the puncture lower down between the first and second dorsal vertebrae, which produces as perfect and deep analgesia for the segment of the body comprising the head, neck, and upper limbs as is produced by medio-cervical puncture. Medio-dorsal puncture between the seventh and eighth dorsal vertebrae is very often difficult to perform, and is not necessary, for perfect analgesia of the lower segment of the thorax can be obtained by puncture made between the last dorsal and first lumbar vertebrae, which is easier to perform and produces also anaesthesia of the whole lower part of the body.

I have therefore reduced sites of election for puncture to two—namely:

(*a*) *Upper Dorsal Puncture.*

Upper dorsal puncture between the first and second dorsal vertebrae is easily performed; the landmark is the vertebra prominens with the visible and tangible protuberances of the spinous processes of the second and third dorsal vertebrae. When the patient's head is strongly flexed, so that the chin touches the sternum, the protuberances are very marked, and the spaces they bound are enlarged (Figs. 2, 3, and 4). The patient being placed in this position, the surgeon marks with the forefinger of his left hand the space between the first and second dorsal vertebrae, and the needle, held between the thumb and forefinger and middle finger of the right hand, is pushed in, following the upper border of the spinous processes of the second dorsal vertebrae (Fig. 4). For operations on the head, neck, upper limbs, and thorax the puncture should be made in this situation.

(*b*) *The Dorso-Lumbar Puncture.*

The dorso-lumbar puncture between the twelfth dorsal and first lumbar vertebrae is very easily made, owing to the large space which separates the two spinous processes. (Figs. 2 and 3). I prefer this puncture to the classical lumbar puncture between the third and fourth lumbar

vertebrae, because it produces more perfect analgesia of the whole abdomen and lower segment of the body. The space is easily found, for it is necessary only to count the lumbar spines upwards. The patient is seated with the thorax bent strongly forward, as in ordinary lumbar puncture (Fig. 5). In making the puncture, the forefinger of the left hand marks the space, while the needle is pushed in with the right hand, following the upper border of the underlying spinous process.

In both cases the puncture is made in the median plane. Once the resistance of the skin has been surmounted, the needle must be pushed forward slowly, so as not to tear the tissues which are being transfixed. As a rule the needle enters easily as far as the dura mater, when a momentary resistance is felt; when this has been overcome, the flow of spinal fluid shows that the needle is in the right space. When the puncture is made at the high dorsal level, where the pressure of the cerebro-spinal fluid is diminished, it comes out drop by drop, whereas in the dorso-lumbar puncture it spurts out in a stream. This is the rule, but there are exceptions, for sometimes in the high dorsal puncture no fluid escapes; an effort of coughing will then usually suffice to make it appear, although it may be necessary to adapt a sterilized syringe to the needle in order to aspirate the fluid. If no fluid is thus obtained, the surgeon must conclude that his needle is not in the arachnoid cavity; the point of the needle must be disengaged, drawn back slightly, and pushed in again until the space is found. If the needle is introduced obliquely it may impinge on a lamina, but the peculiar sensation of having touched bone will warn the surgeon; he must then withdraw the needle completely and reintroduce it in the proper way — namely, in the median plane. If the fluid which escapes is blood-stained, it shows that a small vein has been transfixed—a matter of no importance, since the haemorrhage will soon cease spontaneously and the fluid become clear.

It is also possible to make the punctures with the patient lying on his right side, the head being strongly bent on the chest for the high dorsal puncture, and the thorax being bent forward for the dorso-lumbar puncture. This position should be preferred when the patient is feeble or very impressionable and cannot remain in the sitting position without risk of fainting; it must also be used if, an operation having lasted longer than was anticipated, a second puncture and injection to prolong the analgesia become necessary.

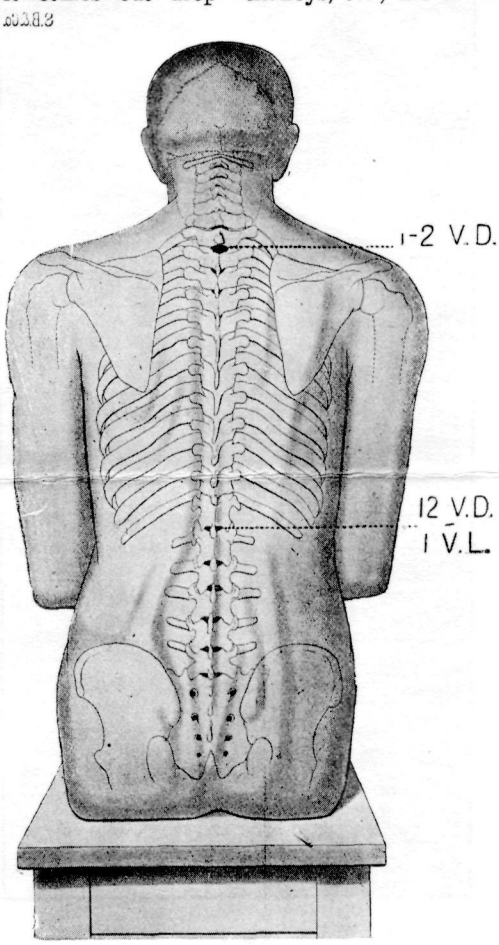

Fig. 2.

4. *The Injection.*

As soon as the escape of cerebro-spinal fluid renders it certain that the arachnoid space has been entered, its further loss should be stopped, for I am convinced that the escape of more than a certain quantity of fluid is rather harmful than useful. The loss of too much fluid (1) may cause signs of faintness, pallor of the face, sweating, etc.; and (2) by suddenly diminishing the quantity of cerebro-spinal fluid may cause too rapid diffusion of the anaesthetic, which is undesirable and may be mischievous. As soon, then, as a few drops of fluid have escaped, the needle is closed with the forefinger of the left hand, while with the right the syringe filled with the anaesthetic mixture is adapted to the needle. The liquid must be slowly injected so as not to produce an undue impact upon the spinal cord.

5. *Position of Patient after Injection.*

The position to be assumed by the patient after the injection, so as to ensure analgesia of the region to be operated upon, is a cardinal point, for by attention to it we can favour the distribution of the liquid in the desired direction. If with the higher dorsal injection it is desired to obtain analgesia of the head and neck, the patient is made to lie on his back; if the operation is to be on the throat, the head should be a little raised; if on the face or skull, he should lie horizontally; if on the upper limb or the thorax, he should remain sitting for two or three minutes, and then lie on the back with the head, neck, and thorax bent slightly forward. If after four or five minutes the analgesia of the head or of the neck is not complete, the patient's head should be lowered below the level of the body for three or four minutes.

With dorso-lumbar injection if the viscera of the upper abdominal region (liver, stomach, spleen, pancreas, kidneys, etc.) are to be operated upon, the patient must remain in the sitting posture for two or three minutes, and then lie on the back, the head neck, and shoulders being raised. If after five or six minutes the analgesia is incomplete, the patient must be inclined (Trendelenburg) for a few minutes three or four, after which he again returns to the sitting posture. If the operation is on the lower abdominal region (pelvis, perineum, external genital organs) or on the lower limbs, the patient should remain in the sitting posture for five or six minutes, and then lie on his back, with the upper part of the body, head, neck, and thorax raised and bent forward.

6. *The Dose.*

The amount of stovaine and strychnine in the anaesthetic mixture should vary with the site of the injection, the patient's age, and his general condition. I confine my remarks to stovaine, as it is the drug with which long practice has made me familiar, so that I can administer it with precision and safety. I cannot speak with equal confidence of other anaesthetics, such as novocain and tropacocaine, with which I have had little experience.

(1). *Strychnine.*

The variation in the quantity of strychnine is not relatively great. For the higher dorsal injection I employ: For children of from 1 to 5 years $\frac{1}{3}$ mg. in 1 c.cm. The solution is made by dissolving $3\frac{1}{2}$ cg. of neutral strychnine sulphate in 100 grams of sterilized water. For children above 5 years, for adolescents, adults, and aged people the solution contains $\frac{1}{2}$ mg. of neutral strychnine sulphate in 1 c.cm., and is made by dissolving 5 cg. of the strychnine salt in 100 grams of sterilized water. For dorso-lumbar injection, for children from 1 to 10 years old, I use a solution containing 1 mg. of strychnine in 1 c.cm.; for children above 10 years, adolescents, adults, and old people, a solution containing 1 mg. in 1 c.cm., made by dissolving 10 cg. of the neutral strychnine sulphate in 100 grams of sterilized water.

(2). *Stovaine.*

The amount of stovaine varies with the site of the injection, the patient's age, and his general condition. For the higher dorsal injection I use for children from 1 to 5 years old, 1 cg.; from 5 to 15 years, 2 cg.; for adolescents, adults, and aged people, 3 cg. For the dorso-lumbar puncture, for children from 1 to 5 years, 2 to 3 cg.; from

5 to 15 years. 4 to 6 cg.; for adolescents from 15 to 20 years old, 6 to 8 cg.; and for adults and aged people 10 cg. The dose of stovaine must also be adapted to the general condition of the patient. In persons who are consumptive, very anaemic, who are suffering from autointoxication or grave infections, or who have suffered severe injury, or are ischaemic owing to profuse haemorrhage, 5 or 6 cg. of stovaine produce deep and prolonged analgesia, and larger doses are badly tolerated, causing pallor of the face, nausea, vomiting, and transient faintness.

In order to be able to judge of the degree of the diffusibility of the liquid injected into the arachnoid cavity the specific gravity of the solution of strychnine and stovaine compared with that of the cerebro-spinal fluid must be known. The average density of cerebro-spinal fluid is 1,003, but it varies from 1,003 to 1,020 [2] Dr. Hancu, Chief Pharmacist to the Coltza Hospital, has found that the following solutions have the specific gravity stated:

	Grams.	Sp. gr.
1. Strychnine	0.05	
Stovaine ...	2.00	... 1,0019
Water ...	100.00	
2. Strychnine	0.05	
Stovaine ...	3.00	.. 1,0030
Water ...	100.00	
3. Strychnine	0.10	
Stovaine ...	6.00	... 1,0071
Water ...	100.00	
4. Strychnine	0.10	
Stovaine ...	8.00	... 1,0105
Water ...	100.00	
5. Strychnine	0.10	
Stovaine ...	10.00	... 1,0120
Water ...	100.00	

The solution used for injection in high dorsal puncture (containing 3 cg. of stovaine and ½ mg. of strychnine) has a specific gravity equal to or greater than the average density of cerebro-spinal fluid; this fact explains the rapid diffusion towards the cervical part of the cord and the cranial cavity, which, as will be shown later, takes place if the injection is made here, and also the readiness with which analgesia is produced. The solution used for injection in the dorso-lumbar puncture has, on the other hand, a specific gravity greater than that of cerebro-spinal fluid, and the larger the quantity of stovaine the higher the specific gravity. In this situation the diffusion of the solution takes place slowly, a fact which explains the relative delay in the production of the analgesia, and partly also the harmlessness of the Trendelenburg position, the solution tending to remain in the lower parts of the arachnoid cavity.

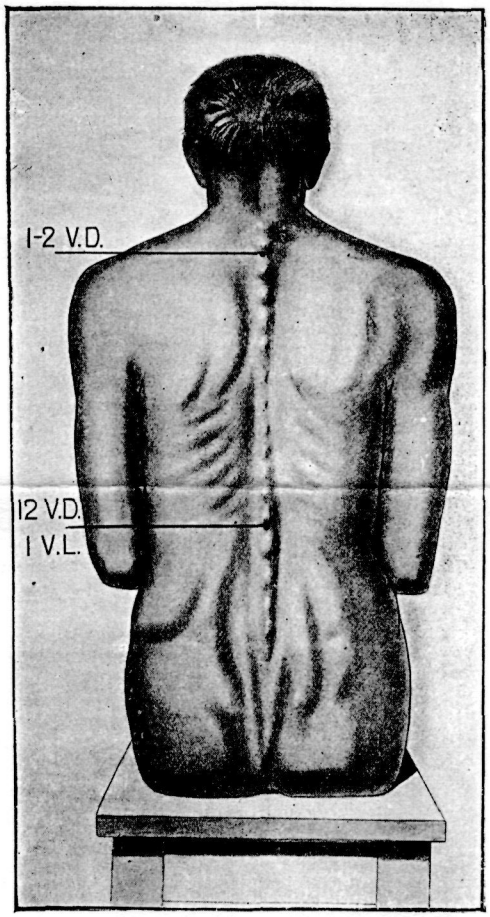

Fig. 3.

PHENOMENA OBSERVED DURING ANALGESIA.

With the higher dorsal puncture the analgesia is, for the reason just stated, usually complete in two or three minutes. On the other hand, after dorso-lumbar injection, analgesia is produced more slowly, but is complete in at most ten minutes. If analgesia is not obtained within this time, it is evidence that the solution has not reached the arachnoid cavity, or has reached it in too small a quantity, and the puncture and injection must be repeated. It is a mistake to attribute failure to produce analgesia to idiosyncrasy. It is true that I have seen some cases in which after puncture followed by a flow of cerebro-spinal fluid no analgesia has been produced, but a second, or in some cases a third injection of the same dose of the anaesthetic has produced complete analgesia. It is tempting to suppose that these patients were refractory to normal doses and required larger doses, but this is a mistake; no patient could support 20 to 30 cg. of stovaine and 2 or 3 mg. of strychnine without presenting marked bulbar phenomena—stoppage of breathing and of the heart—attributable to the excess of stovaine. The occurrence must be otherwise explained. It is to be attributed to an untimely movement of the patient at the moment of the injection, very trifling, perhaps, in appearance, but sufficient to displace the point of the needle already engaged in the arachnoid cavity. Owing to the slight and imperceptible displacement the orifice of the needle is withdrawn partly or wholly from the cavity, and the solution is therefore injected in part or in whole outside the cavity, between the dura mater and the osseous canal.

In one case of high dorsal puncture I only obtained analgesia after a third injection—that is to say, after using 9 cg. of stovaine and 1½ mg. of strychnine, doses which no patient could support without showing bulbar phenomena. It is certain, therefore, that only the third injection penetrated the arachnoid cavity. In another case of dorso-lumbar injection, in a patient in whom on a previous occasion excellent analgesia was obtained with 6 cg. of stovaine, 16 cg. in two injections failed to give any result, and it was only after a third injection of 6 cg. that analgesia was produced.

During analgesia patients retain full consciousness, and I am in the habit of speaking to them to divert their attention from the operation, of which the majority are unaware, the operating field being hidden from them by a cloth supported by two bars attached to the operating table at the level of the neck. I prefer this cloth to a mask, which is embarrassing to the patient and a great trial to his patience during a long operation. A patient may be heard to ask after an operation is finished when it is to be begun.

The immobility of the limbs, the neck, and the head, due to paresis caused by the spinal analgesia, is a great advantage to the surgeon by suppressing movements which might embarrass him. It is true that there may be complete anaesthesia without loss of mobility in the limbs this rarely happens, but its occurrence ought to be known, as it is not necessary to wait for paresis before beginning to operate.

After dorso-lumbar injection the abdominal viscera, including the intestines, are immobile, and this "abdominal stillness" is a great advantage, especially in gynaecological laparotomies. The viscera are, as it were, congealed, are not stimulated by any fit of coughing or effort of vomiting and therefore do not obstruct the field of operation, as happens so often with inhalation anaesthesia.

The occurrence of such phenomena as pallor of the face, nausea, or sweating, so often observed when spinal analgesia is produced by the injection of stovaine, tropacocaine, or novocain is seen only exceptionally when the stovaine and strychnine solution is used. The face retains its normal aspect; nausea occurs in 2.25 per cent. vomiting—a single effortless ejection—in 1.25 per cent. and sweating in 2 per cent. In some cachectic, feeble individuals I have observed faecal incontinence (4 per cent.). The pulse, which is slowed in spinal analgesia produced by stovaine alone, is, when the stovaine and strychnine solution is used, usually normal in rapidity and strength Sometimes it rises to 80 or 90, but always remains strong. These facts prove the powerful influence of the strychnine

in neutralizing the depressing action of the stovaine. Under certain special conditions I have in 5 cases observed momentary stoppage of respiration; in 3 of these cases I had used for medico-cervical puncture a solution to which atropine $\frac{1}{3}$ mg. had been addded. I have abandoned both the use of atropine and puncture in this situation. In one other case I had used for high dorsal injection 4 cg. of stovaine, too large a dose, as subsequent experience has proved. In the fifth case dorso-lumbar puncture had been preceded by subcutaneous injection three and a half hours before operation of scopolamin and morphine. In this case, as I had feared in view of the poisonous effects of so powerful a drug as scopolamin, the respiration stopped, and was only re-established after fifteen minutes. None of these accidents can be attributed to the method that I have here described, but to departures from it which ought to be avoided.

Duration of Analgesia.

The analgesia, when the anaesthetic is administered in the manner described, lasts from one and a half to two hours, a period longer than is necessary to perform any operation. I should add for the benefit of surgeons inexperienced in spinal analgesia, that though the condition may be obtained with less than 3 cg. of stovaine in high dorsal puncture, and less than 10 cg. in the dorso-lumbar puncture, the anaesthesia is neither so deep nor so durable. With 8 cg. analgesia may be produced, but the patient preserves sensation of contact and of traction on the viscera, or on the sides of the wound. With 10 cg. all sensation is abolished; for this reason there should be no hesitation in using doses which may seem large, but which are harmless and produce complete anaesthesia. If an operation has lasted so long that the analgesia passes off, I make another puncture with the patient in dorsal decubitus, and in this way analgesia can be prolonged as long as may be necessary without inconvenience. The dose used for the second injection should be either equal to that given in the first or smaller, according to the probable duration of the operation.

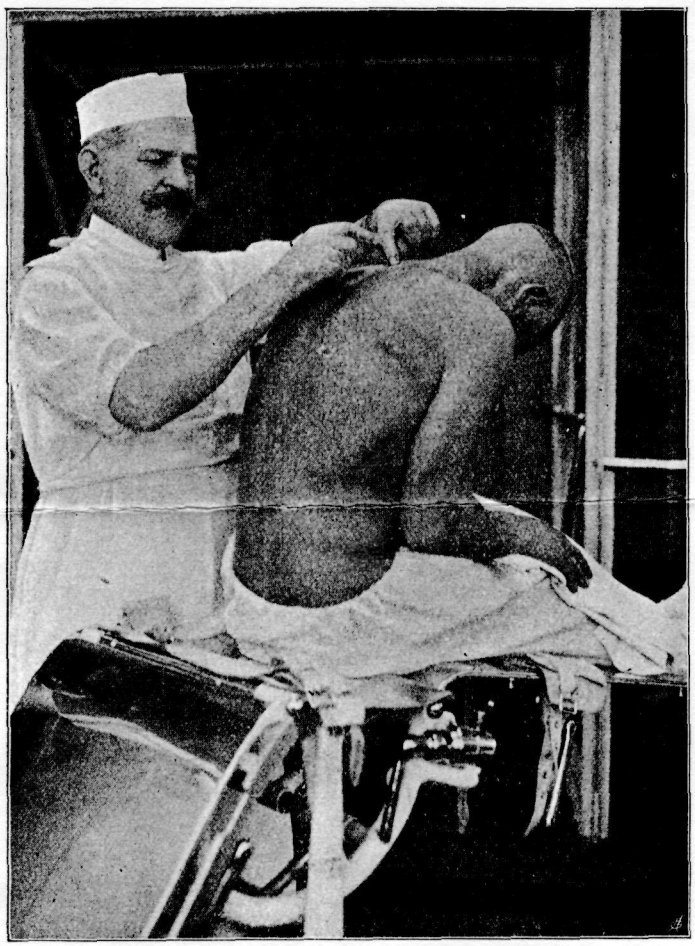

Fig 4.

Phenomena after Analgesia.

Headache, retention of urine, and a rise of temperature, frequently observed when spinal analgesia is produced by stovaine alone, are seldom noted, and are of short duration when the method here described is followed. Headache has been observed in 6.25 per cent., but is not severe and disappears in a few hours. Transitory retention of urine was observed in 4.5 per cent., but only in those operations in which it is also produced with inhalation anaesthesia, such as those on the anus, the uterus, and for hernia. In no case did the temperature reach 40° C. (104° F.); a temperature as high as 39° C. (102.2° F.) was observed on the evening of the day of operation in 1.75 per cent.; of 38° C. (100.4° F) in 16 per cent.; of 37° C. (98.6° F) in 50 per cent. Post-operative vomiting has rarely been observed, and I have never seen post-analgesic paralysis.

Statistics.

The following are statistics of 398 operations performed by means of general spinal analgesia, from October 23rd, 1908, to July 5th, 1909.

I. High Dorsal Analgesia, 103 Cases.

(*a*) *Operations on the Skull*, 14.—Decompressive herni-craniectomies, for epilepsy (12); trephining of the mastoid process (1); angioma of the forehead (child 2 years old), extirpation (1).

(*b*) *Operations on the Face*, 45, including extirpation of epithelioma of the inferior lip, with extirpation of the submaxillary and submental glands (22); harelip, autoplasty, child, 3 years old (1); extirpation of a naevus of the labial commissure (1); cancer of the tongue, with extirpation of the submaxillary and submental glands (1); ectropion, autoplasty (5); ptosis of the superior eyelid, autoplasty (1); epithelioma of the inferior eyelid, autoplasty (1); paralysis of the left facial, myoplasty (1); sebaceous cyst of the orbit, extirpation (1); cancer of the orbit, enucleation (1); retro-ocular phlegmon, Kroenlein's operation (1); osteoma of the orbit, Kroenlein's operation (1); naso-pharyngeal polypes, Oliver's operation (5); resection of the superior maxilla (1); oste-operiostitis of the superior maxilla, trephining (1); osteo-sarcosis of the two submaxillary bones, resection (1).

(*c*) *Operations on the Throat*, 23. — Cervico-thoracic sympathectomy (11); resection of the superior cervical sympathetic ganglions (1); thyroidectomies (6); total laryngotomy for cancer (1); tracheotomy (1); external oesophagotomy for foreign body (set of teeth) (1); dorso-cervical lipoma, extirpation (1); cervical phlegmon, incision (1).

(*d*) *Operations on Thorax*, 7.—Cancer of the breast, large extirpation (Halsted-Balacesco-Legueu-Tiersch) (3); amputation of the breast with extirpation of the axillary gland (2); cystic disease of the breast, extirpation, and extirpation of the axillary glands (1); resection of ribs (1).

(*e*) *Operations on the Upper Limb*, 14.—Fracture of the clavicle, Lambotte suture (3); axillary adenitis, extirpation of the glands (2); axillary lipoma, extirpation (1); scapulo-humeral luxation (17 days), reduction (Kocher) (1); osteomyelitis of the humerus, trephining (1); enormous sarcoma of the arm, extirpation (1); ankylosis of the elbow, resection (1); autoplasty of the flexor tendons (1); section of the flexor tendons, tendinous sutures (1); tendinous dermoid cyst, extirpation (1); sanguineous redressment of the fingers and amputation of the thumb (1).

II. Spinal Dorso-Lumbar Analgesia, 295 Cases.

(*a*) *Laparotomies*, 52, including eventration (5); exploratory laparotomies (5); tuberculous peritonitis, laparotomy (2); Talma's operation (1); abdominal hydatid cyst, marsupialization (1); hydatid cyst of the liver, marsupialization (1); hydatid cyst of the liver, incision, extirpation, suture (5); cholecystectomies (4); splenectomies (8); gastro-enterostomies (5); resection of the pylorus, with gastro-enterostomy for ulcer (6); intestinal occlusion, laparotomy (2); appendectomies (6); iliac anus (1).

(*b*) *Gynaecologic Laparotomies with Inclined Plane*, 49, including hysterectomies (35); hysterectomies, with extirpation of the ilio-lumbo-pelvic ganglions for cancer of the uterus (5); retroflexion of the uterus, plications of the large ligaments, and intra-abdominal shortenings of the round ligaments (1);

atrophic ligatures for inextirpable cancer of the uterus (4); ovariectomies (3); extrauterine pregnancy (1).

(*c*) *Hernia, Radical Cure*, 70, including inguinal unilateral hernia (49); bilateral inguinal hernia (9); strangulated inguinal hernia (5); inguinal hernia with appendicitis (1); unilateral crural hernia (1); bilateral crural hernia (1); strangulated crural hernia (2); umbilical hernia (2).

(*d*) *Kidneys, Urinary Bladder*, 8.—Nephrectomy (1); nephropexies (3); hypogastric cystotomies (3); exstrophy of the urinary bladder (1).

(*e*) *Rectum and Anus*, 26.—Cancer of the rectum, abdomino-perineal extirpation (1); ano-rectal cancer, perineal extirpation (1); haemorrhoids, extirpation (Whitehead) (14); rectal stricture, extirpation (1); anal fissure, dilatation (2); anal stenosis, dilatation (1); rectal fistulae, cauterization (2); peri-anal vegetation, extirpation, cauterization (2); papilloma analis, extirpation (2).

(*f*) *Operations by the Vaginal Route*, 31.—Curettage of the uterus (20); vesico-vaginal fistulae (11).

(*g*) *External Genital Organs of Man*, 7.—Unilateral castration (2); radical cure of varicocele (4); radical cure of hydrocele (1).

(*h*) *Perineum*, 7.—Fistula and abscess, incision, curettage (6); perineorrhaphy (1).

(*i*) *Abdominal Coat*, 2.—Sarcoma, extirpation (2).

(*j*) *Lower Limbs*, 43.—Coxo-femoral luxations, reduction (4); coxo-tuberculosis, plaster apparatus (1); inguinal adenitis, extirpation (1); adenosarcosis, extirpation (3); fracture of the femur, Lambotte suture (1); myoma of the adductors, extirpation (1); varices, resection of the saphena (2); white tumour of the knee, arthrectomy and plaster apparatus (4); disarticulation of the knee (1); amputation, Sabanejeff (1); ankylosis of the knee, reduction (2); genu valgum, osteotomy (1); osteotomy of the leg bones (2); amputation of the leg (3); Lambotte suture of the tibia (3); extraction of pieces of metallic sutures (2); fractures of the leg bones, plaster apparatus (4); phlegmon of the leg, incision (1); transplantation of tendons, osseous resection for infantile paralysis (1); club-foot, Phelps's elongation of the tendo Achillis (4); incarnate malextraction (1).

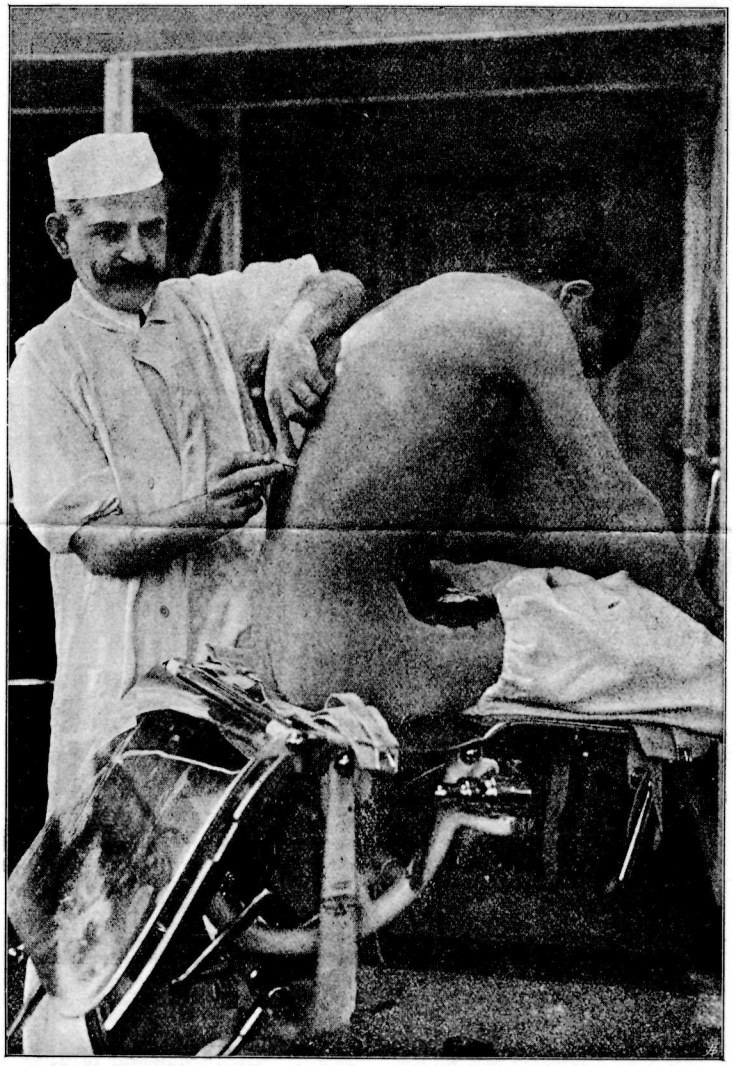

Fig. 5.

The ages of the patients have varied from children of 1 year 9 months to old people of 75 years. I have operated on 15 children under 10 years old, 1 of 1 year 9 months, 4 of 2 years, 1 of 3 years, 2 of four years, 1 of 5 years, 2 of 6 years, 2 of 8 years, 1 of 9 years, and 1 of 10 years. They all supported the injection perfectly with the doses I have above indicated. Therefore age is not a contraindication.

With regard to the general condition of the patient, chronic cardiac, pulmonary, renal, or hepatic diseases do not contraindicate the use of the method described. I have operated on persons with advanced cardiac diseases, such as myocarditis, aortic insufficiency, and mitral stenosis or insufficiency, without inconvenience; the same can be said as to other chronic affections. Further, acute or chronic infectious diseases are not contraindications, but the dose of the anaesthetic must be diminished. Neither angular nor lateral curvature interferes with success, save in exceptional cases of ossification of ligament. If to these 398 cases I add the statistics which I presented to the Congress at Brussels relating to 617 operations performed from July 6th, 1904, to July 25th, 1908, with lumbar, medio-cervical, or superior dorsal spinal analgesia (14 cases), I have a total of 1,015 spinal analgesias without a death, and without any serious complication either during analgesia or afterwards. Of earlier statistics, I need only recall that I have performed:

27 laparotomies (among them 2 splenectomies, 3 resection of the pylorus with gastro-enterostomy, 3 intestinal resections, 6 detortions of volvulus, 5 appendectomies, etc.); 24 gynaecologic laparotomies, with inclined plane (9 hysterectomies, 2 hysterectomies for cancer, with extirpation of the lumbo-ileo-pelvic ganglions, 12 atrophic ligatures for inoperable cancer of uterus). I have done also 14 first operations on the head, the neck, the thorax, and the upper limb, with medio-cervical or superior dorsal puncture (among them 1 temporary hemicraniectomy, 1 enucleation of the eye, 1 thyroidectomy, 2 resections of the cervico-thoracic sympathetic for exophthalmic goître, 1 suture of the clavicle, 1 Halsted operation for cancer of the breast), etc.

Before concluding, I ought to add that two of my old pupils, now assistant surgeons to the hospitals—Drs. Jiano and Nasta—have been good enough to give me their statistics of operations under spinal analgesics produced by my method.

Dr. Jiano, operating in the first surgical clinic of the faculty (Senior Surgeon, Professor Severeano) at the Coltza Hospital, has had 114 cases, including 20 supero-dorsal or medio-cervical punctures (operations on the head, neck, thorax, and upper limb), and 94 dorso-lumbar punctures (operations on the abdomen, pelvis, perineum, and lower limb). Dr. Nasta, operating in the Dr. Racoviceano-Pitesti Clinic in the Colentina Hospital, reports the following: 19 dorso-superior and 78 dorso-lumbar punctures. In all these cases the results were excellent.

Deducting 603 lumbar analgesias with stovaine alone, I have 412 cases of analgesia with my new method—398 indicated in this paper and 14 published at Brussels—with 117 high injections, medio-cervical or supero-dorsal, and 295 low dorso-lumbar injections. Adding the cases of Drs. Nasta and Jiano, I have a total of 623 operations done by means of my method from July, 1908, to July, 1909, of which 156 with medio-cervical or supero-dorsal puncture—operations on the head, neck, thorax, upper limb—and 467 with dorso-lumbar puncture—operations on the abdomen, pelvis, perineum, lower limb, etc.

CONCLUSIONS.

1. The fundamental principles in spinal analgesia are that puncture of the arachnoid may be performed at all levels, and that to the anaesthetic, whether stovaine, tropacocaine, or novocain, strychnine should be added.

2. Puncture of the arachnoid at whatever level is harm-

less, and the fear of pricking the cord unfounded; even if it happens it is not harmful.

3. Medio-cervical puncture is useless and dangerous; mid-dorsal puncture is difficult and useless; superior dorsal puncture between the first and second dorsal vertebrae, and dorso-lumbar between the last dorsal and first lumbar vertebrae are easy, and suffice to obtain analgesia of all regions of the body.

4. The addition of neutral strychnine sulphate to the anaesthetic preserves the full antiseptic power of the solution and at the same time neutralizes its injurious action upon the bulb. Thanks to this addition, superior spinal analgesia can be performed without danger.

5. Among known anaesthetic substances, stovaine, tropacocaine, and novocain seem to be the best; any of them may be used with the addition of strychnine.

6. The strychnine and the anaesthetic substance need not be sterilized, a process which would destroy some of their properties.

7. The water used for making the solution must be sterilized but not distilled.

8. The injection should consist of 1 c.cm. of solution, the amount of strychnine and anaesthetic substance being varied.

9. The technique is simple, requiring only a Pravaz syringe and the usual needle for lumbar puncture.

10. There are no contraindications for general spinal anaesthesia, which always succeeds if the liquid penetrates into the arachnoid cavity and if the dose of the anaesthetic is sufficient.

11. General spinal anaesthesia is absolutely safe; it has never caused death, nor produced any important complications, early or late.

12. General spinal anaesthesia is infinitely superior to inhalation anaesthesia. Owing to its simplicity, it is within the reach of all, and as there is no contraindication it may be employed with any patient. As it can be performed by the surgeon himself it does away with the attendance of a person often inexperienced, and never responsible.

13. In operations on the face, or the throat, where analgesia by inhalation is difficult and often incomplete, spinal analgesia is a great resource. In laparotomies, owing to the "abdominal silence" it determines, it is very much superior to analgesia by inhalation.

14. The facts stated in this paper will prove how in science a condemnation *a priori* like that pronounced by Professors Bier and Rehn is precipitate and ill-founded.

15. I am firmly convinced that general spinal analgesia will be the analgesic method of the future.

REFERENCES.
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THE DEPARTMENTAL COMMITTEE ON HUMIDITY AND VENTILATION IN HUMID COTTON-WEAVING SHEDS.

BY COLONEL MATHEW D. O'CONNELL, M.D.

IN the Warrant of appointment of the Departmental Committee on Humidity and Ventilation in Cotton-Weaving Sheds, the Home Secretary asks the Committee to say: "At what degrees of heat and humidity combined definite bodily discomfort arises, under the conditions of the work carried on by the operatives, and what, if any, danger to health is involved by continuous work at those degrees."

Being for many years much interested in the question of the effect of combined heat and humidity in raising body temperature in warm and hot climates, I made some observations on a number of healthy men at rest, exposed within glass houses heated by 5-in. pipes, and, when it appeared, by the sun, and humidified by sprinkling the earthen floor with water at the natural temperature. The air within the glass houses was still. These houses are used for growing orchids, crotons, ferns, grapes, and tomatoes. The men during exposure wore their coats or not as they pleased. The body temperature was taken in the mouth. My object was not to ascertain how high body temperature can be raised by exposure to high degrees of atmospheric heat and humidity, for this is known; but to ascertain, if possible, the lowest degrees of atmospheric heat and humidity combined at which body temperature begins to rise above the maximum normal limit—37.2° C. (99.0° F.).

In each observation I give the dry-bulb temperature, the wet-bulb temperature, the absolute and the relative humidity of the atmosphere; for there seems to be some uncertainty as to which of these atmospheric factors is the cause of body temperature rising. So I think it better to give all. The observations are as follows: The drying power of the air is given per 10 cubic feet, as this is approximately the bulk of an average man.

From my own sensations in the glass houses and in warm and hot climates, I would say that bodily discomfort begins as soon as the body temperature begins to rise above the maximum normal limit, 37.2° C. (99.0° F.), from impediment to heat loss from the body. When body temperature begins to rise above this normal limit from increased production of heat in the body, as from exercise in the open air, I have not noticed the same discomfort until the body temperature reaches nearly 37.7° C. (100.0 F.). But in this paper I am not concerned with rise of body temperature from increased production of heat, but only from impediment to heat loss.

In order to apportion the relative importance of each meteorological factor of the atmosphere within the glass houses in producing rise of body temperature by impeding heat loss from the body, it is necessary to remember that heat is lost from the body by radiation, by evaporation, by conduction and convection, and by the excreta.

Loss of Heat from the Body by the Excreta.

As no excretions were voided during the short exposures in the glass houses, this need not be further referred to.

Loss of Heat from the Body by Radiation.

The rate at which any radiating body gives off heat depends on the difference between its own temperature and that of the surrounding air. When the dry-bulb temperature of the surrounding air is the same as the normal temperature of man—36.8° C. (98.4° F.)—no heat is being lost from the human body by radiation. As the dry-bulb temperature of the surrounding air falls below the temperature of the body, loss of heat from the body by radiation increases. When the dry-bulb temperature of the air falls to 0.0° C. (32.0° F.), or over sixty degrees below the temperature of the body, loss of heat from the body by radiation must be considerable.

Loss of Heat from the Body by Evaporation.

The rate at which heat is being lost from the body by evaporation depends on the drying power of the surrounding air, that is, its capacity for taking up water vapour. The drying power of cold air is small. At 0.0° C. (32.0° F.), air can contain only 21 grains of water vapour per 10 cubic feet when saturated. As at such temperature air is always nearly saturated, the amount of vapour it can take up is very little. Consequently loss of heat from the body by evaporation is little. Thus in air having a dry-bulb temperature of 0.0° C. (32.0° F.), when loss of heat from the body by radiation is considerable, loss of heat by evaporation is inconsiderable.

As the dry-bulb temperature of the air rises the drying power of the air increases, and as the dry-bulb temperature falls the drying power of the air falls. Whilst air having a dry-bulb temperature of 0.0° C. (32.0° F.) can only contain 21 grains of water vapour per 10 cubic feet, at 10.0° C. (50.0° F.) it can contain 41 grains; at 21.1° C. (70° F.) it can contain 80 grains; and at 36.8° C. (98.4 F.)—that is, at the temperature of the human body—it can contain 193 grains per 10 cubic feet. Hence as the dry-bulb temperature of the air rises, and loss of heat from the body by radiation decreases, the drying power of the air and loss of heat from the body by evaporation increase. In like manner, as the dry-bulb temperature of the air falls and loss of heat from the body by radiation increases, the drying power of the air and loss of heat by evaporation decrease. Thus it seems that loss of heat from the body by radiation and loss of heat from the body by evaporation are usually complementary one of the other; and for this reason exposure to great extremes of atmospheric temperature can be borne without abnormal increase or

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