obstructed by blood and mucus; (5) they remain in position much better than do rubber tubes; (6) they are much easier to clean and sterilize.

They are made in three sizes accompanied with a Y-shaped glass connecting tube which is used for operations on the upper part of the head (Figs. 9 and 10).

1925 Seventh Avenue.

SPINAL ANALGESIA—DEVELOPMENT AND PRESENT STATUS OF THE METHOD

WITH BRIEF SUMMARY OF PERSONAL EXPERIENCE IN
1,065 CASES *

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Spinal analgesia proves no exception to the general rule which applies to new methods. Its early development was fraught with mistakes, some of which were serious and even fatal. When it was heralded throughout the world that Bier had successfully injected cocaine into the spinal subarachnoid space, many surgeons adopted the method. It was a new field and little was definitely known concerning the physiologic aspects of the question, and little more with reference to the therapeutic phases of the subject. It was but natural that, as the literature of spinal analgesia developed, the number of unfortunate experiences multiplied. It was inevitable, too, that enthusiasm should wane, and that the further development of the method should be left to a limited number of surgeons who recognized in spinal analgesia a procedure of distinct advantage, with a definite field of usefulness.

Following Bier's first demonstrations of the surgical application of spinal analgesia, report of which was published in 1899, the method was quite extensively employed for two or three years. Accounts of its use then disappeared almost entirely from medical and surgical literature, though it was not abandoned by the few earnest advocates of the method. The revival of the subject in the literature about five years ago is familiar to all. It is safe to assume that spinal analgesia is now permanently established among recognized surgical procedures, and will never again so nearly approach abandonment as it did during the short period of quiescence which followed its first few years of popularity.

A just estimate of the merits of any method can be reached only by a study of the accumulated experience of many observers. It is manifestly impossible on this occasion to trace the evolution of spinal analgesia by a review of the literature which chronicles the findings of the large number of surgeons who are now employing or have employed the method.

During the early stage of the development of spinal analgesia cocaine and eucain were the agents most generally employed. This fact probably accounts for many of the adverse opinions formed of the method. Eucain gave a "patchy" and hence altogether unsatisfactory analgesia. Cocaine was not entirely satisfactory, partly because of the reckless dosage employed by many surgeons, and partly because of the difficulties experienced in sterilizing the drug without destroying its analgesic effect or decomposing it in such a way that its by-

products gave rise to unpleasant accompanying or post-operative phenomena. Bier early protested against the reckless manner in which cocaine was being employed, and against the dangerously large doses which some operators used. He made a plea for an effort to find less harmful drugs for the production of spinal analgesia.

A very important part of the evolution of spinal analgesia has been concerned with the discovery of other drugs and other combinations, which would give a controllable analgesia, and at the same time lessen the dangers and eliminate the frequently disagreeable accompanying symptoms associated with the method. In the endeavor to find such a drug a great deal of careful experimental work has been conducted by different investigators. The results have been remarkably successful, and have given to the method a definite field of usefulness.

My experience with cocaine was not so unfavorable to that drug, probably because at an early stage of the development of spinal analgesia I formulated a plan of sterilizing the agent,¹ which insured not only a sterile but a fresh and active solution, free from the harmful by-products so often claimed to be present and generally attributed to the methods of sterilizing by heat.

It is not necessary here to enter into the question which from time to time has been raised concerning the validity of the claims that cocaine is decomposed by heat and its analgesic properties destroyed as a consequence. Whether correct or incorrect, the impression has gained currency that boiling decomposes solutions of cocaine. Various methods of sterilizing this agent have, therefore, been suggested. The simplicity of the method which I have employed renders it of value for emergency work, where a rapid method is required to secure a sterile, potent solution. The method, which is applicable to other analgesic agents as well as to cocaine, is as follows:

Five grains of fresh cocaine crystals, carefully weighed, are placed in a sterilized measuring glass. Two drams of strong ether are added and mixed thoroughly with the cocaine crystals by means of a sterilized glass rod until a paste is formed. The mixing process is continued until all the ether is evaporated and a dry powder is obtained. One-half to 1 ounce of boiled, filtered water, or sterile normal salt solution, is then added. One-half ounce makes practically a 2 per cent. solution and 1 ounce a 1 per cent. solution. The dosage varies, according to the age of the patient, the region to be operated on, etc., from 5 to 25 minims of the 2 per cent. solution, and from 10 to 40 minims of the 1 per cent. solution.

The crystals, if kept dry, do not deteriorate, as do other forms of the drug. It is advisable, however, if possible, to employ only fresh crystals, or to be sure that they have been kept perfectly dry. With active cocaine at one end of the scale and inert cocaine at the other, there are various grades of potency, from an analgesic point of view. The exact cause of this variation is a matter of dispute, some holding that it is due to the heat sometimes employed in sterilization, others denying the correctness of this assertion. The members of the Section on Pharmacology and Therapeutics will doubtless clear up this point in the discussion.

Following the suggestion of Bier, that less harmful agents be found for spinal analgesia, experimentation has led to the employment of the following agents: stovain, novocain, tropacocain, beta-eucain, beta-eucain lactate, alypin, holocain hydrochlorid, orthoform (new).

* Read in the Symposium on Anesthesia in the joint meeting of the Section on Pharmacology and Therapeutics and the Section on Pathology and Physiology of the American Medical Association, at the Sixty-Third Annual Session, held at Atlantic City, June, 1912.

1. Bainbridge: Med. Rec., New York, Dec. 15, 1900.

anesthetin, and other agents. Cocain, stovain, novocain and tropacocain are the drugs most generally used, with stovain, perhaps, in the lead.

Other drugs than cocain having been found available for spinal analgesia, attention was next directed toward making such combinations of these with other substances as to render the solution heavier or lighter than the cerebrospinal fluid, the object being to avail oneself of gravity in controlling the height of the analgesia. Experimentation along this line has led to some very interesting results, and has evolved three general classes of solutions: (1) those of lighter specific weight than the cerebrospinal fluid; (2) those of approximately equal weight; (3) those of heavier weight.

To the first class belongs the so-called "diffusible" solution employed by Babcock, in which alcohol is used to render the fluid lighter than the cerebrospinal fluid.

To the second class belong the simple solutions of the analgesic agent with water, with water plus cerebrospinal fluid, with cerebrospinal fluid alone, or with normal salt solution.

To the third class belong the so-called "non-diffusible" solutions, which are rendered heavier than the cerebrospinal fluid by the addition of glucose, dextrin or gum arabic.

To any of these solutions may be added, if desired, epinephrin or some similar product, as employed by Bier, Gray and many others, or strychnin, as suggested by Jonnesco.

In 988 of my 1,065 cases simple solutions, of the second class, were employed, the agent being sterilized after the manner described, and dissolved in plain sterile water, without the addition of any other drug. In over 500 of the 988 cases cocain was used. In the remainder the various other agents and combinations were employed. I now use, as a rule, stovain or tropacocain, because fewer unpleasant symptoms are apt to ensue, but I do not hesitate to employ cocain.

In the 1,065 cases there was one death (with the diffusible stovain solution, probably due to status lymphaticus); one case of temporary partial paralysis with complete recovery;² one case of failure due to so-called "dry spine," in which puncture at different levels failed to bring cerebrospinal fluid; two cases with alypin, in which there was considerable respiratory depression, and one case of idiosyncrasy in which, after several attempts by spinal and local injection, the analgesia was almost nil. In all the other cases there were no accompanying or post-operative symptoms of permanent or serious moment.

ILLUSTRATIVE CASES WITH THE THREE CLASSES OF SOLUTIONS

SIMPLE SOLUTION (COCAIN WITH WATER)

CASE 1.—J. P. D., aged 31, was operated on Nov. 27, 1902, (case of Dr. William T. Scovil, of Richmond Hill, Long Island), under spinal analgesia, which I administered. The patient had been operated on two years before by Dr. George Ryerson Fowler for appendicitis, at which time ether anesthesia was employed. The patient suffered for a year and a half from postanesthetic asthma of such severity that it was necessary for him to sit up at night in order to breathe. This gradually subsided and for six months before I saw him he had not been troubled with it. When I was called in consultation, the patient was suffering from multiple strictures, which had become so tight that there was almost complete retention of urine. A filiform bougie could not be passed. Albumin and casts were present in the urine. Chronic endocarditis further complicated the condition. The patient's testimony was abso-

lutely necessary in a forthcoming murder trial in which circumstantial evidence was so strong against the defendant that a verdict of guilty was almost a certainty. Nothing but the patient's testimony could save the man.

Treatment.—To operate under inhalation anesthesia was practically impossible. It was determined, therefore, to employ spinal analgesia. Cocain, 20 minims of a 2 per cent. solution, was injected and external and internal urethrotomy performed. Analgesia lasted two hours and ten minutes. The patient read and smoked during the operation. In two weeks he went into court, gave his testimony and cleared the defendant. The patient, who is still living and in a fair degree of health, has never suffered from asthma since the operation under spinal analgesia—an interesting coincidence at least.

CASE 2.—Mrs. M. D., aged 43, was admitted to the New York Skin and Cancer Hospital in October, 1911. Examination revealed a large deep tuberculous ulcer of the left leg, 6 by 5 inches in diameter, of three years' duration. On Dec. 20, 1911, the ulcer was excised, and the surface exposed to fulguration according to the de Keating-Hart method, with the long, high-frequency, high-tension, electric spark. Analgesia in this case was induced by means of 20 minims of a 2 per cent. solution of cocain. Eight minims injected at first proved insufficient, and after ten minutes another injection of 12 minims was made. Analgesia was complete to the nipple line in four minutes and lasted over an hour. There were no accompanying or postoperative symptoms of any moment, convalescence being entirely uneventful.

GLUCOSE-EPINEPHRIN-STOVAIN SOLUTION (NON-DIFFUSIBLE)

CASE 3.—L. L., female, aged 58, was admitted to the New York Skin and Cancer Hospital, March 18, 1911, for operation for lipomas of the abdominal wall, papilloma of neck, angiomas of abdominal wall and varicose veins of the legs. The operation was March 20, 1911. Various growths were removed, and the varicose veins excised. Analgesia was induced by the glucose-epinephrin-stovain, so-called "non-diffusible" solution obtained from Gray, of London, one ampule, 2 c.c., 3 per cent. stovain, being injected. Adjuvant medication consisted of strychnin, 1/60 grain, and nitroglycerin, 1/200 grain. Analgesia extended to the neck, and lasted for one hour and fifty-five minutes. There was no nausea, no vomiting, no headache, or other unfavorable symptoms. The patient was cheerful throughout the operation, her facial expression giving no evidence of pain or distress. Recovery was uneventful.

The only death which I have to chronicle in my 1,065 cases occurred when the Babcock "diffusible" solution was employed. It may be stated in advance, however, that the fatality is not necessarily attributable to this agent.

STOVAIN-ALCOHOL-WATER (DIFFUSIBLE)

CASE 4.—The patient, a male child, aged 2, on my service at Randall's Island, New York City Children's Hospital and School, was in very poor general condition, with chronic bronchitis, some dulness in the chest and distressing inflammation and prolapse of the rectum. Operation was definitely indicated, and inhalation anesthesia was positively contra-indicated. It seemed justifiable, therefore, to attempt to relieve the condition by operation under spinal analgesia. An injection of 0.5 c.c. of the Babcock diffusible stovain solution was employed. The child died almost immediately after the injection was made. Autopsy was not allowed, but from the apparent slight enlargement of the thymus gland which was present, the dulness in the chest, and the general appearance of the child, it may be that death was due to that more or less mysterious condition known as status lymphaticus. We may give the diffusible solution the benefit of the doubt.

The following case illustrates the successful application of the method by means of the diffusible solution:

CASE 5.—J. R., female, aged 50, was received at Randall's Island. Operation, Dec. 14, 1911, consisted of panhysterectomy for fibroid tumors of uterus and cystic ovaries, the incision and suture of "Lane's bands" and appendectomy. Preliminary medication consisted of 1/4 grain morphin

2. Bainbridge: Med. Rec., New York, 1900, LVIII, 937.

and 1/200 grain atropin hypodermically half an hour before operation. Spinal puncture was made in median line between first and second lumbar vertebrae; 3 c.c. of stovain-alcohol solution injected, at 10:15. Analgesia was complete to nipple line at 10:19. Median abdominal incision was made at 10:25; patient experienced no pain or discomfort. Exploration revealed three distinct peritoneal bands, narrowing the lumen of the ileum and causing marked angulation at the crest of the pelvis. These were sectioned and sutured, and the appendix removed. This part of the operation was completed by 10:45, and panhysterectomy begun. At 11 o'clock the patient complained of discomfort due to the stretching of the abdominal wound, but cutting, suturing or clamping the tissues caused no pain. Her condition at this time was excellent. At 11:30 patient asked for a drink of water, which was given her, with a small quantity of whisky. Respiration and pulse were regular, and the expression of the face revealed no real discomfort. There was no nausea, no vomiting and no coughing at any time during the operation. The color of the skin remained good throughout. Operation was completed and abdominal wound closed at 12 noon. Patient left table at 12:05, talking quietly, and in excellent condition. Analgesia persisted for one hour after completion of the operation. At no time did the patient's temperature rise above 101 degrees F. There were no postoperative complications. recovery was uneventful, and at the end of the third week the patient was walking around the ward perfectly well.

The patient in this instance was an ideal illustration of the field for spinal analgesia. She was old beyond her years, with some thickening of the arterial walls, with abnormally small kidneys, excreting urine of low specific gravity, with some albumin and casts. There was no postoperative interference with the action of the kidneys, such as would very probably have occurred after the administration of ether.

With certain notable exceptions, both the experimental and the clinical investigations of the early period of the evolution of spinal analgesia were concerned with the production of analgesia below the diaphragm, and its application to the surgery of these regions. It is not to be wondered at, however, that the advocates of the method were unwilling, in many cases, to rest with this limited field of application to the lower parts of the body, and that they began to extend it to the parts of the body above the diaphragm.

Tait and Caglieri of San Francisco, Morton of the same place, Chaput of France, and others, performed operations on various parts of the body above the level of the diaphragm, as early as 1900, thus antedating this particular part of the work of Jonnesco of Bucharest, by about eight years. Tait and Caglieri, in 1900, reported three cases in which cocaine was injected into the sixth cervical space, without untoward effects. The patients were examined weeks after the injection and found to be free from any complication. Similar results were obtained by others.

So far as I have been able to ascertain, the work of Tait and Caglieri, Morton, Chaput and others, with high injection, has not been followed up with further clinical applications, and for this reason, perhaps, originality in this regard has been generally accorded to Jonnesco. The "new method" of spinal analgesia reported by Jonnesco in 1908 consists in piercing the spinal column at all levels, according to the operation, and injecting stovain, novocain, or tropacocain, with strychnin, into the subarachnoid space. As is well known, Jonnesco considers the fact that the respiratory nerves are not involved in the high injections as due to the influence of the strychnin.

I have never employed the high-injection method of Jonnesco, in either the original or the modified form (in

which he confines the injection to the superior dorsal and the dorsolumbar sites). I have been able, however, in some instances, to operate on practically any portion of the body under spinal analgesia as induced by the various solutions, plus the head-high or the head-low position of the patient. Years ago I used strychnin and glonoin hypodermatically as supportive and corrective medication at the time of the spinal injection. The only thing new in Jonnesco's method, so far as strychnin is concerned, is injecting this drug, with the analgesic agent, into the canal.

The evolution of spinal analgesia was not completed with the discovery of less harmful agents as suggested by Bier. With the perfection of combinations of the analgesic agents with other substances, giving a more or less diffusible solution and a consequently more or less controllable analgesia, and with the extension of the application of the method to the upper part of the body, the indications and contra-indications for the method have also been carefully studied, and no inconsequent part of its development is concerned with the widening of the scope of spinal analgesia.

One of the most telling illustrations of this increased sphere of application is its use with children. In the earlier days of spinal analgesia perhaps the majority of writers on the subject named infancy and childhood among the contra-indications. Even now many advocates of the method do not approve of its use in this class of patients.

In the early stage of the application of spinal analgesia I began to employ the method, being particularly interested at that time in its use in young children. Several cases of children operated on under spinal analgesia were reported by me,³ the youngest being 2½, the oldest 11 years old. The former patient was apparently the youngest on whom the method had been employed at that time. I reported an additional series of forty cases,⁴ twenty-four of which were given in detail, the youngest being 7½ and the oldest 19 years of age. In July of the same year I reported twelve operations⁵ on infants and young children, the youngest of this series being 3 months and the oldest 5 years of age.

Since that time a large number of children have been operated on by various surgeons, the most notable series of cases being that reported by H. Tyrrell Gray, of the Hospital for Sick Children, London. He employed the method in all abdominal work on children, holding that when it is used the mortality record in such cases is materially lowered.

Along with the perfection of the method in the matter of agents, sites for injection, scope of application, etc., there was much to be evolved with reference to the preliminary preparation of the patient, the selection of the analgesic agent best suited for the given case, the careful estimation of the dose required for the individual patient and the actual technic of injection.

As the method has been developed, various needles and syringes for the injection have been devised, and the technic has been varied to suit the ideas of the individual operator. Time does not permit, nor is it necessary, to detail the different modifications of the method. The technic which has answered my needs best is given below.

PRELIMINARY PREPARATION OF PATIENT

Preliminary preparation of the patient as regards diet, catharsis, etc., which is of so great importance in

3. Med. Rec., New York, Dec. 15, 1900.
4. Med. News, May 4, 1901.
5. Arch. Pediat., July, 1901.

inhalation anesthesia, is not so essential in spinal analgesia, except in operations on the intestines. In a certain percentage of cases incontinence of urine and feces occurs from relaxed sphincters, when rectum and bladder have not been emptied. Patients coming into the hospital from the street, with no preliminary preparation, have been operated on as successfully, and with as few accompanying and postoperative phenomena, as have those who have been subjected to the most careful preparatory care. Generally speaking, however, attention to all details which conserve the patient's vitality and comfort should be observed.

A hypodermic injection of morphin ($\frac{1}{8}$ to $\frac{1}{4}$ grain), combined in some cases with atropin or scopolamin, may be given half an hour before spinal puncture. It serves to tranquilize the patient and to make him less susceptible to any possible pain or discomfort contingent on the initial procedure. Bromids instead of morphin may be given the day before, or nitroglycerin ($\frac{1}{200}$ to $\frac{1}{100}$ grain) may be advantageous, administered at the time of injection. Strychnin ($\frac{1}{60}$ grain) given subcutaneously at the time of the spinal injection is supportive. Combined with nitroglycerin it lessens the danger of headache, shock and other disagreeable symptoms.

No preliminary medication is given to children.

APPARATUS

The apparatus for giving the injection of the analgesic agent consists of a syringe and two cannulas.

The syringe, which is made by Ford and Company or the Kny-Scheerer Company of New York, is entirely of metal, including the piston, so that it expands uniformly on boiling. It has a capacity of 5 c.c., the corresponding quantities in the two systems being graduated on the piston.

The cannulas are made in two sizes, of three lengths. The points are ground short and beveled, with a cutting-edge all round. The shank is of flexible metal, so that it will bend without breaking. The cannula slips on a ground joint, fitting accurately the handle, without washers or screws. The proximal end is fitted with a handle which can be firmly grasped. Through the cannula runs a stylet, the proximal end of which is rounded, knob-like, so that it can be pressed against the base of the index finger, adding firmness of grip.

The entire instrument can be taken apart and thoroughly sterilized.

TECHNIC OF INJECTION

The usual aseptic precautions are observed. The site of puncture may be cleansed in the usual way, by scrubbing, etc., or by painting the skin with tincture of iodine. The patient, in the sitting posture, the feet hanging over the side of the table, with the puncture site painted with iodine, is draped with a sterilized sheet. This sheet has cut in it a hole or window large enough for purposes of injection. The operator, in making his examination and identification of landmarks, runs no risk of contaminating his hands by contact with skin surfaces which have not been rendered aseptic.

The site of puncture is now determined in the following manner:

1. The highest points on the crests of the ilia are located. On this level is the spinous process of the fourth lumbar vertebra.

2. The sites of the second, third, fourth and fifth lumbar vertebrae are marked.

3. The thumb is placed in the space between the twelfth dorsal and first lumbar, second and third

and fourth, or fourth and fifth lumbar vertebrae, according to the selection of site, at the mid-point between the two. One-half inch to either side of this is the site for the puncture. I usually inject between the fourth and fifth or third and fourth lumbar vertebrae.

The puncture-point being located, the assistant plays a spray of ethyl chlorid on the area, or, if preferred, a preliminary subcutaneous injection of cocain or other local analgesic agent may be given. A small incision is now made through the true skin, which may be rendered hemostatic as well as analgesic by the ethyl chlorid.

The needle is passed through the incised skin and subcutaneous tissue, straight forward. The head is then depressed, the point being made to go upward, forward and inward toward the median line. It is inserted from $1\frac{1}{2}$ to $2\frac{1}{2}$ inches, according to the thickness of the patient's body.

When the needle is felt to impinge on the bone surrounding the foramen, it is depressed a little more and pushed forward, when it comes on the ligamentum subflavum, then the dura mater. In piercing the ligament and dura there is a peculiar sensation like the "popping" of a membrane. This signifies the entrance to the subarachnoid space.

The cerebrospinal fluid escapes under ordinary circumstances. If it does not flow freely something is wrong. The needle may not have entered the right place, or it may be clogged. A stylet should not be inserted into the needle. Another syringe should be ready, and with this, if one cannot draw out blood or fluid, the needle should be withdrawn entirely and then, after being rendered patent, reinserted. I prefer not to proceed with the injection unless the fluid issues with at least an approximate quantity and tension. Others, notably Gray,⁶ are not agreed on this point, being willing to proceed with the injection when the fluid issues only in slow drops, or when it is slightly blood-stained.

In some cases, despite careful technic and repeated attempts at different sites, no cerebrospinal fluid is obtainable. Such cases have doubtless led to the expression "dry spine," but it is rather to be inferred that they come under the category mentioned by Gerstenberg and Hein,⁷ Lusk⁸ and others, in which the arachnoid membrane is adherent to the posterior surface of the cord at the levels entered, so that no fluid is obtained for the reason that, at the given locality, the subarachnoid space is obliterated posteriorly. I have had one such personal experience. Despite four attempts, in each of which the canal was entered, two between the fourth and fifth, one between the third and fourth, and one between the second and third lumbar vertebrae, no fluid was obtained. The attempt was then abandoned and the operation (appendectomy) successfully performed under ether anesthesia.

The analgesic solution is now injected slowly. The obliquity of the passage of the needle has the advantage that no tract is formed for the fluid to follow as the needle is withdrawn. The body of the vertebrae in front should not be touched with the needle, because of the presence there of a large plexus of blood-vessels. When the needle is withdrawn a cotton and collodion dressing is applied.

If low analgesia is desired for operations on the lower part of the body, the patient should be allowed to sit up for a few minutes after the injection, or the head should

6. Gray: *Lancet*, London, Sept. 25 and Oct. 2, 1909.

7. Gerstenberg and Hein: *Ztschr. f. Geburtsh. u. Gynäk.* 1907-1908, lxi, 524; also *Verhandl. d. Gesellsch. f. Geburtsh. u. Gynäk. zu Berlin*, 1907-1908.

8. Lusk: *Ann. Surg.*, October, 1911.

be elevated, when solutions of the same or heavier specific weight than the cerebrospinal fluid are used. If the lighter fluid is employed, it must be borne in mind that the head must be lowered *at once* after the injection to prevent the rapid diffusion of the analgesic agent and the danger of death from respiratory paralysis. When high analgesia is desired, for operations on the upper parts of the body, the patient may be placed in a more or less marked Trendelenburg position, with the heavier solutions. The "diffusible" solution may be used if, after the initial lowering of the head, the head of the table is slowly and carefully elevated. My own feeling is that operations on the head and neck should not be undertaken under spinal analgesia unless other methods are absolutely contra-indicated and operation is essential.

SUMMARY

From the weight of conflicting testimony with reference to the indications and contra-indications for spinal analgesia, it may be deduced, in a general way, that, granting the need of operation and the impracticability of local or regional analgesia, *the indications for spinal analgesia are the contra-indications for inhalation anesthesia*. So far as the character of the operative procedure is concerned, there are practically no contra-indications to the employment of spinal analgesia. A person already in marked shock or profoundly septic should not be subjected to this procedure. A number of surgeons with wide experience accept practically no limitations to its use. Some operators firmly believe that in certain cases this method is safest and best.

The real objections to spinal analgesia in my opinion are:

1. The operator is absolutely committed to the dose, whatever it be. It can be increased by an additional injection, but it cannot be decreased once given. With the changes in the position of the patient, with carefully graded dosage, control can be exercised.

2. In prolonged operations the analgesic effect may pass before the surgical procedure is finished. In some cases, as in laparotomy, it is quite inconvenient to turn the patient over for another injection.

It would be safe to assume that even its most enthusiastic adherents would not advocate the usual employment of spinal analgesia by the surgical novice. It must, therefore, continue to occupy a somewhat limited sphere until further accurate and scientific experimentation has led to more certain conclusions with reference to the physiologic action of the agents employed and the dosage in which they may be used to obtain a given result. Until such information is definitely in hand, spinal analgesia should be employed, as a rule, only by those experienced with the method and having careful technique.

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ABSTRACT OF DISCUSSION

ON PAPERS OF DRs. BASKERVILLE, ALLEN, GWATHMEY, MILLER, LUMIARD, TETER AND BAINBRIDGE

DR. F. J. COTTON, Boston: The question of doing better work in anesthesia is largely one not of diminishing the deaths "on the table," but of diminishing those indirectly due to the anesthetic. There are, for instance, the deaths from ether from lung complications. It was a short series of deaths from that source that made me take up nitrous oxid-oxygen anesthesia. As Dr. Teter has said, it is the anesthetic of choice for routine work, when it can be administered by experts. Both this and spinal anesthesia are expert propositions; they

will not become surgical routines for big hospital clinics. That, however, is no reason against their use where we can have our own way.

I have not had a large experience with spinal anesthesia; I think that proper administration makes it safe and satisfactory. I have had it given a good many times by Dr. Allen and Dr. Richardson, of Boston, and have found it satisfactory. The cases in which it seems to me that it would not be satisfactory to use any other form of anesthesia are those of diabetic gangrene and those of seriously damaged kidneys. These patients do better under spinal anesthesia, and I have been afraid to use nitrous oxid on them. The objection to spinal anesthesia, in addition to the fact that it requires an expert to administer it, is twofold: first, on the part of the patient; and secondly, on that of the surgeon. First, there are patients on whom it cannot be comfortably used; even if one anesthetize such a patient at the head, by talking to him, he is more or less nervous. Second, it takes long practice to do work with any kind of anesthesia when consciousness on the part of the patient is not abolished. To do good work under such conditions takes a rather callous temperament or long practice. There is great convenience in having a visible supply of gas. Oxygen is the only gas of which it is important to have a visible measure, but it is convenient to have a visible supply of both. Some form of bubbling arrangement is necessary—to enable one to see whether the oxygen is flowing. The development of cyanosis is so prompt under nitrous oxid and oxygen that if there is any hitch, there is trouble very soon. Anything that gives information on this point is rather worth while. Dr. Teter has not spoken of the furthering of an even flow by working from low pressure. This advantage is commonly accepted to-day, though it is relatively new in the handling of this anesthetic method.

PROF. YANDELL HENDERSON, New Haven, Conn.: I urged yesterday in the House of Delegates (and it seems to me that the matter of statistics tends to bear out the point) that deaths under anesthesia are not really due to anesthetics, but to anesthetists. That is, if we are going to diminish the deaths under anesthesia, we must have capable anesthetists—I am not giving an expression of opinion one way or another as between nurses and interns. The principal point that the Committee on Anesthesia urged was that everything should be done that can be done to recognize anesthetists—to have a department of anesthesia for every large hospital and to put it under the control of the attending anesthetist, as the medical or surgical work is under the control of the attendant in medicine or surgery. This work should be managed by the attending anesthetist, just as it is by Dr. Allen at the Massachusetts General Hospital. This is of the utmost importance. Dr. Teter spoke of the quantity of carbon dioxide that is allowable. In an early paper, I set the limit at 5 per cent. That is too low, but there were not sufficient data at that time to enable us to know how much would be safe. It is clear now that it is quite safe to go to 10 per cent., and very likely 15 would not be dangerous.

The New York Society of Anesthetists, which was organized last winter, has been the means of bringing the anesthetists in the neighborhood of New York into personal contact, which is important for their mutual advantage and the advancement of anesthesia; and they have felt that it would be well to have a national society of anesthetists. It seems to me that to bring the anesthetists all over the country into contact and give them a feeling of solidarity, so that they may work together and insist on their rights, is most necessary.

DR. W. WAYNE BARCOCK, Philadelphia: My experience in spinal anesthesia does not date back so far as Dr. Bainbridge's; but eight years ago, I began to use spinal anesthesia and since then I have employed it in nearly all cases in which the operation was below the level of the nipple, except when the patient or the family physician expressed a prejudice. I began with heavy solutions and found difficulty in securing uniform anesthesia. Gradually, I worked away from the heavier solutions and used the lighter, and found that the range of the anesthesia became greater. Finally, by adding alcohol to reduce the specific gravity, I found I could produce

an anesthesia that would involve any part of the body, even to the top of the head. The specific gravity of the anesthetic being less than water, if the patient sat erect it would soon rise to the upper cord. This fact involved certain dangers, and I soon discarded the high anesthesia, and as a rule limited the use of the anesthetic to operations below the nipple. There is an apparent general misconception as to the nature of spinal anesthesia; it is not a cord anesthesia, but a nerve-root anesthesia. Therefore, with higher injections, the patient may be completely paralyzed in the upper part of the body, but still capable of using the legs, and with tactile and other senses preserved in the feet, showing that the conducting paths in the cord functionate although certain nerve-roots are involved. This is important, as when the anesthesia is rather high, paralysis of the nerves controlling the diaphragm results in the abolition of diaphragmatic breathing. As this occurs, the chief muscles of the chest having been thrown out of function, the patient may by accessory muscles make ineffective efforts toward respiration. If such a patient be left alone, he will die; but if artificial respiration be instituted, even though the dose of the spinal injection be large, the patient will again start breathing, although perhaps not for fifteen or twenty minutes. The anesthetic has little influence on the heart, and by artificial respiration the patient may be kept alive, even after tremendous doses of the anesthetic.

Spinal anesthesia is contra-indicated in conditions that prevent the efficient use of methods of artificial respiration. It is especially useful in heart disease and in the other conditions described by Dr. Bainbridge. In regard to the objections, first that the patient is conscious, Dr. Bainbridge has shown how patients may almost enjoy the operation. Some, indeed, do seem to enjoy it. Those who are nervous, on the other hand, may readily have their higher centers abolished by injections of scopolamin and morphin. There is more and more a tendency to use narcotics, so that the patient comes down to the operating-room in a "twilight sleep."

DR. R. C. COBURN, New York: Clover was the originator of the beneficial method of rebreathing, but it was on a very unscientific basis until the work of Henderson, who presented it in such a light that it is now susceptible of almost universal application. I strongly disagree with one of the speakers, who said that nitrous oxid is administered by rebreathing on account of the money that this saves, and that there is no principle involved that renders it safer, such as the matter of the increased carbon dioxide in rebreathing. While it is true that under nitrous oxid anesthesia there is less shock than under any other form, and that the anesthetic *per se* does not produce shock, yet under its influence there is a smaller amount of carbon dioxide in the blood, and therefore, a greater call for its retention than with any other anesthetic. As a corroboration of Henderson's theory as to the effect of the retained carbon dioxide in the administration of anesthetics, I want to cite personal observation that in abdominal operations in which the viscera are exposed and there is opportunity for the carbon dioxide to transpire into the surrounding air, the patient will tolerate a double amount of rebreathing, i. e., twice as much as in other conditions in which there is little exposure of the capillary blood-vessels.

A point in the administration of ether that corroborates this is that when a patient is under a light anesthesia, the shock is greater than under deep anesthesia, especially in abdominal operations. It is my experience that in the administration of ether, when one uses an extra amount of rebreathing, keeping the carbon dioxide at normal or more, the patients will undergo operations under light anesthesia with practically no shock. I believe that this is due to the increased carbon dioxide provided through the extra amount of rebreathing. In abdominal operations, in which this observation has been especially made, the carbon dioxide has the opportunity of transpiring into the surrounding air; and it is much lower in such operations than in those in which there is no such opportunity for the carbon dioxide to pass off into the air. While it is true that rebreathing in the

administration of nitrous oxid reduces very materially its cost, I am quite sure that it is not the proper reason to give; and I am quite sure that the men who have been primarily engaged in the production and the promotion of nitrous oxid anesthesia with rebreathing have not placed their work on that basis.

PROF. YANDELL HENDERSON, New Haven, Conn.: I did not say what Dr. Coburn thinks I did. What I said was that the method of rebreathing started as a question of cost. I would say that we have no exact measure of rebreathing in the individual patient, and until we have some clinical measure of rebreathing, it is not on an exact basis.

DR. ROBERT H. FERGUSON, East Orange, N. J.: While I use the open-drop method almost exclusively in my work, I now merely call attention to my belief that about 92 per cent. of all the ether anesthetics in the United States are by the open-drop method. This opinion is formed from a careful scrutiny of all the statistics I can get, together with personal observations made in many hospitals in over 75 per cent. of the states of the Union. Further, I believe that when anesthetics by this method have not been so good as were desired, the failure has been due to unskilful administration, perhaps aided by an improperly arranged apparatus, rather than to the method itself. A point, then, I wish to make is this, that instead of endeavoring to bring out new apparatus and multiplying methods we ought to concentrate our attention on one simple procedure, such as the open-drop method, and perfect it. After its range of usefulness is determined it will be right to study exhaustively another method, if the first is unsatisfactory. Experimentation in anesthesia ought, however, to be of the most conservative kind, since the safety and comfort of the patient is involved. To a mind impressed with such a necessity, the little advance made in a simple method of administering ether during the last twenty-five years is a matter of regret.

As regards anesthetic statistics, we should be very patient, not content with a small number, with those of one locality only or with any of a doubtful or limited value. Dr. Cotton has suggested that the majority of our anesthetic statistics are of small value. I believe that such is the fact chiefly because they are not complete. As an illustration let me say that it has been my duty, from time to time, to investigate so-called anesthetic deaths in various parts of the United States. Often, when my attention has been called to one death, I have found nine or ten in that vicinity. Again, while on the train, coming to this meeting a surgeon told me that the hospital with which he was connected averaged five chloroform deaths a year although his patients always had ether. I could give other illustrations. Now practically none of these deaths are reported in print. Some were mentioned at meetings of local societies but were you or I collecting data for statistics of anesthetic deaths none of these cases would be available. I think these facts are strikingly conclusive of the untrustworthiness of our anesthetic statistics. I wish that every hospital and every surgeon would realize the importance of putting on permanent available record every death, directly or indirectly due to the anesthetic, together with full details of the case.

DR. T. D. BUCHANAN, New York: I want to report without pride two unsuccessful cases, merely as a warning and possibly a help to some of you, as surgeons or anesthesiasts, in diagnosing the same thing that I ran across. After fifteen years of specializing in anesthesia in New York City without any deaths, I came across two cases in two weeks and lost both patients, one under ether, and one under gas and oxygen. Both patients had enormous fibroid tumors of the uterus, both were pretty well exsanguinated by frequent hemorrhages, and both died very suddenly in the midst of the operation. Now statistics with regard to deaths on the table are very hard to get. The causes of the deaths of this sort in the hospitals with which I have been connected were hard to find. Each time that I went to investigate one, the surgeon would say that it was an anesthetic death, and the anesthesiast would say that it was caused by shock. That is why we cannot get statistics. In my own cases of fibroid,

the deaths were due solely to the anesthetic. I make this excuse for myself, however: that in a number of fibroid cases there is fibroid degeneration, not only of the uterus, but of other parts and tissues of the body, and frequently of the heart. There are numerous authorities for that statement, and I believe that this is what I encountered. I have known other deaths to occur following fibroid operations, ten or twelve hours afterward, but not on the table. The first case might have been due to my not paying attention to the anesthetic, but the second surely could not have been, because I had just had a warning a week before from the other fibroid case, and was watching every second. The second death, as I have said, occurred under nitrous oxid and oxygen. We should have a very wholesome respect for these cases, and not keep the patients in the Trendelenburg position longer than necessary; and the anesthetist and surgeon should avoid throwing even the slightest strain on the heart.

DR. A. F. ERDMANN, Brooklyn, N. Y.: I take this opportunity of thanking some whose names I cannot recall for sending to me the sample anesthetic charts for the society and other libraries. I have a collection of nearly a hundred; some of them are certainly queer. Three or four are very long, a number are very short; some contain only few details, others have space for numerous data; most of them omit important matter, so valuable that I cannot see of what use they really are. As a matter of fact, few charts are properly kept, mainly, I believe, because the intern realizes that pulse-rate, amount of anesthetic used and length of time of operation tell practically nothing of the course of his labor. May I suggest that we go over our charts again to see if there is not something to add to them that will make them more interesting to yourself or to some one else, and which will give them a value for those who like Dr. Gwathmey are endeavoring to gain knowledge of this subject for the common good? Until we use good charts and have them kept conscientiously we cannot expect to be able to gather reliable statistics.

DR. F. R. WIDDOWSON, Philadelphia: Dr. Buchanan, in his discussion, brought up the subject of statistics. I suppose, if he has had experience in looking up statistics of this character in a hospital, he has found them to be of little value, owing to the way in which these records are usually kept. I think that the reason why Dr. Gwathmey failed to get reports from many hospitals was their inability to render a report of value from the imperfect records. If a hospital does not have a form, as Dr. Erdmann has just said, on which the anesthetist can record the data concerning the administration of an anesthetic, the records regarding anesthesia will be very meager. For those who teach and have charge of the anesthetic work in hospitals, the first thing is to have a "form" on which data are collected systematically. If the administrator knows he has to make a record of these things on a chart, he will attend to his work in a more systematic manner, think of the different points, and derive more benefit therefrom. I would say to the surgeons and anesthetists here: One of the best things you can do is to have an official chart made for your hospital when you return. If you have one, you can improve on it, getting additional data. Then when Dr. Gwathmey or some other anesthetist tries to get statistics, he will be able to get them satisfactory to himself and to you, and it will be a pleasure, for the hospital asked, to give them.

DR. FRANK W. PINNEO, Newark, N. J.: There are four principal elements necessary for the success of insufflation anesthesia, which the report of the Committee on Anesthesia recognizes; that is, first, the warming of the vapor in the insufflation apparatus. The three other factors are maintenance of a steady air-pressure; a cock on the apparatus to determine and govern the delivery of vapor to the patient, and a catch-bottle to make it impossible for any liquid ether to be carried over to the patient. We ought not to think nitrous oxid and oxygen useless because some ether has to be added and where such an exponent of it appreciates the little ether added it helps to broaden the field for nitrous oxid and multiply its users. Dr. Gwathmey also has pointed out the value of nitrous oxid, which is, as Hewitt

said, "the safest anesthetic known." There is a contra-indication to its use in children under 5 years of age, but here straight ether is usually good, or, in competent hands, with caution, we may be able to use chloroform for induction (never after an initial period of "ether excitement").

DR. F. K. REAM, Chicago: I have been administering nitrous oxid and oxygen for over twenty years for the extraction of teeth. This particular work led me to engage in hospital practice, and my work is largely limited to that now. I have so completely covered the ground of the use of the various methods that I am really apparatus-poor, having purchased most of the outfits on the market; my experience has led me to the selection of two methods. My method of choice is the Teter, using large nitrous oxid and oxygen tanks with continuous, uniform pressure, making it possible to obtain intrapulmonary pressure, as recommended by Dr. Teter. I cannot with any other method on the market obtain relaxation and control my patients without ether, as I can with the intrapulmonary pressure. I consider all other methods substitutes. I think that Dr. Teter's methods and research have done more to eliminate and limit the use of chloroform and ether than those of any living member of the profession.

I have recently had a series of cases in which I used Dr. Coburn's apparatus for a mixed anesthetic and rebreathing. In some of these, I did not use any ether whatever, and obtained splendid relaxation. In cases in which that is possible, the patients, I believe, must be susceptible to anesthesia in order to bring about that condition, but I am satisfied that I can obtain very much more relaxation from nitrous oxid and oxygen under pressure.

DR. J. W. HEIM, Louisville: I disagree with the man who recommended the chloroform-ether sequence for children to whom we do not wish to give chloroform straight. I think that is the most dangerous form of anesthesia. If in giving an anesthetic the beginning is the most dangerous, why should we use chloroform, which is the most dangerous anesthetic, at the most dangerous time? I would rather induce the anesthesia with ether.

DR. W. S. BAINBRIDGE, New York: First, the early mortality from spinal anesthesia cannot, I think, be attributed to cocain, but to the excessive dosage of cocain employed and the wrong technic. From my own experience, I have learned that stovain and tropacocain are the spinal anesthetics of choice. Still, cocain has been uniformly of value in my cases. The only new thing about Jonnesco's method was that he put strychnin with his analgesic drug into the cord. Stovain had been used before; the high puncture was not new; strychnin had been used by others. In 1901, I was personally employing strychnin under the skin to offset any bad effects of cocain in the subarachnoid injection.

By using cocain low in the cord, I have been able to do operations on the top of the head and have had a number of cases of total analgesia. I thoroughly believe that there is such a thing as preanesthetic anticipatory shock, and the person who says to a patient about to take any anesthetic, "Look what is going to happen," is giving him a certain amount of shock, with which the anesthetic has no right to be saddled. Whenever possible, the mind as well as other organs of the patient should be properly prepared for any anesthesia. I think that it is a safeguard to the patient for the surgeon to watch what he is doing. There is likely to be less shock from unnecessary handling of the tissues when the patient is conscious.

I have had children as young as three months sucking the bottle while the operation for incarcerated hernia was going on, and only stopping their sucking of the bottle with a good, ravenous appetite, to give a cough indicating the general bronchitis that was present. Waugh and Lane assert that the use of spinal anesthesia in acute abdominal conditions in children reduced the mortality about 20 per cent.

DR. CHARLES K. TETER, Cleveland: What is the prevailing impurity usually found in nitrous oxid? I have had reported to me within a month two fatal cases in which nitrous oxid and oxygen were used, death being due to impure gas. There are such peculiar symptoms manifested in such cases

that the cause cannot be overlooked. The patients have a very peculiar greenish-red color, and the blood seems almost of a rusty hue. Dr. Clifford U. Collins, of Peoria, Ill., reported a fatal case with these symptoms within the last month. I have had two cases in which these symptoms arose, and in both I found that my gases were impure. I did not have the opportunity to have the gas analyzed, in order to find out what particular impurity produced the condition. The patients were quite sick for a day or two, but recovered. I think that the impurity was probably nitric oxid.

It has been said lately that all that was necessary to make the present nitrous oxid and oxygen apparatus an automobile was the addition of a carburator. If nitrous oxid is the agent used to induce and maintain anesthesia and not as a makebelieve, a more or less complicated apparatus is essential. At present it may be admitted that in the way nitrous oxid is administered by a good many people, it is not the anesthetic. They are really using the closed method of ether, giving 3 or 4 ounces of ether in an hour, but calling it nitrous oxid anesthesia. It requires only an inhaler and a bag and a couple of cylinders to do this; but if one depends on nitrous oxid and oxygen, only using the oxygen to eliminate the asphyxia, one must have more apparatus and also some sense to know how to employ it. I have seen some men give anesthetics who, if they had to pass as stringent an examination in regard to the subject of anesthesia, as a chauffeur has to pass in his examination, would fail.

One must use common sense in employing positive pressure. If it is used to such an extent that stress is thrown on the respiratory mechanism, one is using too much. If there is strain, one should change the pressure. There should be no strain. In the average case, if one uses 6 to 8 mm. of mercury pressure, it will not hamper respiration in the least. If this is too much, the pressure should be released. The reducing of pressure in a cylinder is important in securing a perfectly even flow of the gases.

DR. A. H. MILLER, Providence, R. I.: It is a fact that there have been no reliable statistics of the mortality from anesthetics available, but I do not believe that this should be. I believe that we can get valuable statistics of the mortality from anesthetics. In the first place, we must separate the deaths that occur as the result entirely of the anesthetics from those in which the anesthetic contributed to the fatal result, and from those in which it had no effect in producing the mortality.

DR. JAMES T. GWATHMEY, New York: The statistics, as given this afternoon, are certainly reliable, and more reliable than any heretofore taken. Indeed, they are more reliable and of more consequence to us, for they represent the results of statistics as given in the United States to-day. Dr. Cotton, in his discussion, stated that he doubted their value, because he knew that many unreported deaths occurred under anesthesia, and also that postoperative deaths are probably not reported in these statistics. It is a question whether any postoperative deaths are reported, yet we know that they do occur after all anesthetics. In the last month, I know of a case (a laparotomy) in which a local anesthetic was used. The operation was successful, and a large tumor was removed; the patient died a few days afterward, from pneumonia. The question is so complicated that if we go into the matter of collecting reports of deaths after operation, it is doubtful whether, even if we had the statistics of all postoperative deaths, they would be as reliable as the statistics we have that can be compared with similar ones already in existence. We know that anesthetic statistics are recorded in but few hospitals of America to-day. The fact that I sent out circulars to the hospitals started many of them in the work of compiling statistics; and I would suggest that if it is known that statistics are being asked for they will be more careful in the future.

Anesthetics are in a state of evolution. There is no one accepted method of anesthesia. As to the question of whether local, spinal, morphin or pulmonary anesthesia alone or in

combination is the best method, no one can say positively. Therefore, I should like anyone who is connected with a hospital that has not given statistics, to assist me by asking for a circular to fill in. This report will be the first that has been made of reliable statistics in America.

PROF. CHARLES BASKERVILLE, New York: As to the different prices of ethers, I would say that I make it a rule to pass on the quality, without inquiring about the price. It is immaterial what the price is. That involves a problem of manufacture, which is not generally known, outside of what I have presented in the paper. Some manufacturers make one grade of ether—*anesthetic ether*, they call it. Some make just "*ether*"—chemically pure ether (which is infinitely purer than the *anesthetic ether*), *anesthetic ether*, commercial ether. Ether may be thus of three kinds, and they may all be made in one way. You know the class of labor that many manufacturers employ; and when they get to the packing, there is danger of mixing these ethers. I have had some cases of that kind. It might have been an accident, but it happened. Some manufacturers of ether prepare only one grade, *anesthetic ether*, and some manufacturers who make the different grades can afford to sell commercial ether at a low price. They then rectify a little of that, so as to get just enough to keep their trade in the *anesthetic grade*. It is a perfectly good ether; but if nothing was paid for it, they would lose nothing. Every cent that they get for that is net profit. It costs them nothing to produce it.

The truth is that when we gather statistics we do so for two purposes. One of these is the matter of curiosity. That is all statistics show in one way. The other object is to learn something; and what we want to learn is how to get over the troubles that we have been having. I am convinced that each drug has its specific action and the processes that go on in the human body are the same as those that we control in the laboratory; and that is the whole field of medicine. If we can learn to control the different reactions, we have the problem solved. That is one thing about getting an anesthetic into the system. Of course, I realize that it is dangerous for a chemist to trespass in a field of that kind, but I shall be out of town soon. The anesthetic ought to be sent in approximately at the temperature of the body. It should also be sent in approximately at normal humidity, and both of these have been accomplished by means of vapor anesthesia, whether nitrous oxid or other kinds, if passed through water.

An improvement on Dr. Gwathmey's method is that of Dr. Davis, which consists in saturating vapor with water and warming it afterward, so that it enters with a degree of humidity of 60 or 70 per cent.

ANESTHESIA BY PHARYNGEAL INSUFFLATION *

FRANK WILCOX PINNEO, M.D.
NEWARK, N. J.

The ideal anesthesia includes four factors: (1) an induction, short, tranquil and not unpleasant to the patient; (2) a maintenance, surgical, even, featureless and so absolutely under control that it is but just deep enough each minute for the existing purpose; (3) a recovery, prompt and complete; (4) after-effects, *nil*, i. e., without symptoms, immediate or remote, in any organ, alimentary, respiratory, circulatory or excretory. It is true of every known method that as it approaches this ideal in some respects it recedes in some other; hence the need for adapting the anesthetic and its method of administration to the individual case, choosing the best combination of results attainable.

* Read in the Section on Diseases of Children of the American Medical Association, at the Sixty-Third Annual Session, held at Atlantic City, June, 1912.