STUDIES IN BLOOD PRESSURE BEFORE, DURING, AND AFTER OPERATIONS WITH REFERENCE TO THE EARLY RECOGNITION, PREVENTION AND TREATMENT OF SHOCK.*

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The evidence available at the present time, while by no means sufficient to prove, is yet enough to indicate that we have made great advance in the early recognition, prevention and treatment of shock due to operative interference.

There are two factors in shock over which we have the greatest control—the toxic factor due to the anesthesia, and the traumatic factor due to the operative manipulations. Our knowledge of these factors has been gained from experimental investigations on animals and careful clinical observations.

In the beginning of anæsthesia, chloroform was the anæsthetic of choice. It seemed to have advantages over ether—it was more easily administered, the patient became narcotized with less struggling, was more relaxed during the operation, and the post-operative discomforts were less. But it was soon found that chloroform has distinct dangers—it is more toxic than ether; during its administration the blood

pressure falls more rapidly; sudden deaths occur during its administration and are not infrequent at intervals after an apparently complete recovery from the anaesthesia. These late deaths are due to certain cell changes caused by the toxic action of chloroform. The longer a patient is kept completely narcotized by chloroform, the greater the immediate and later dangerous effects.

These observations gradually led to the substitution of ether for chloroform as the anaesthetic of choice. It must have been these dangers that were the paramount factors in the change, because ether is more difficult to administer, the time required to get the patient completely narcotized is longer; distressing complications, such as cyanosis and locking of the jaws during the administration, are more frequent; the after-effects of ether are more disagreeable than of chloroform; ether is more expensive than chloroform. In spite of these apparent disadvantages, ether won out, because careful observations demonstrated that it had real advantages on the side of safety. The administration of ether attained its highest perfection in the so-called drop method on an open cone.

Surgeons, however, were not satisfied and sought for other methods of anaesthesia which would eliminate even the discomforts and dangers of the perfected method. The dissatisfaction led to various forms of local, spinal, intravenous and rectal anaesthesia.

Convinced that the chief danger of ether was due to its toxicity and finding that many operations were impossible under local anaesthesia alone, surgeons continued their search for a general anaesthetic whose action would be less toxic, or not toxic at all.

Apparently nitrous oxid and oxygen up to the present time is the general anaesthetic with the least toxic effect. As a matter of fact we have no proof that it has any toxic action.

At first the nitrous oxid was employed without the oxygen, as an introductory to ether, simply to shorten the period of the anaesthetic time. It was soon found that it had no ad-
vantage in reducing the amount of ether administered. Then attempts were made to perform longer operations under nitrous oxid alone, and these finally led to the combination of the gas with oxygen which permitted a longer anaesthesia with less cyanosis.

The combination of local anaesthesia with general, such as chloroform or ether, has long been employed. The object, however, of this combination was to reduce the amount of the general anaesthetic to a minimum. Those who employed it did not have in mind that the local infiltration was also of advantage in reducing traumatic shock due to local injury during the operative manipulations.

Operators, of course, have been familiar for a number of years with the fact that there is a definite factor in shock due to the cutting, tearing and handling of tissues during operations, but they seem to have devoted less attention to the reduction and elimination of this factor than to the toxic factor of the anaesthetic. They have been too prone to blame the anaesthetic for their operative and post-operative shock, its mortality and complications, rather than to place some of the odium on their own manipulations.

When I came to Dr. Halsted's clinic at the Johns Hopkins Hospital, in 1892, I found that he had very definite ideas of his own in regard to shock, different from those who had been my teachers in surgery and from the ideas I had gained from reading up to that time. He perhaps emphasized most the factor of hemorrhage, and his operations were more bloodless than any I had witnessed until then. He was also of the opinion that tissues should be handled gently—cut, not torn; that in clamping, the bleeding point only should be caught and not large masses of tissues crushed; that large wounds should be made, because through these the necessary manipulations could be more gentle. He evidently had in mind by these manipulations not only to reduce shock due to trauma, but the better healing of a wound in which the tissues were less injured. He also endeavored to operate with the least amount of ether possible. Dr. Halsted was
among the first, perhaps the first, to practise local anaesthesia, because it was safer.

When I began to investigate surgical shock and to critically review the literature (*Progressive Medicine*, December, 1899, p. 155) I read and reviewed the experimental work on surgical shock by George W. Crile (J. B. Lippincott Co., Philadelphia, 1898)—an essay awarded the Cartwright prize in 1897.

It is my opinion that we owe to Crile more than to any other writer our knowledge of the factors which produce shock, and of the early recognition, prevention and treatment of this definite surgical complication. In the sixteen years since his first publication Crile has continued his experimental investigations and has added to them great clinical experience. This has resulted in the development of a definite technic—a combination of local and general anaesthesia.

The paramount object of this new technic is to reduce the toxic action of the general anaesthetic and the traumatic factor of the operative manipulations to a minimum. The technic consists of general anaesthesia by nitrous oxid and oxygen, with little or no ether, and infiltration of all tissues divided or handled with 1:400 novocain.

This technic makes the operative time longer, puts more labor on the surgeon, requires infinite patience.

I am confident that it will never become popular until it is clearly demonstrated that it does reduce shock and operative mortality, post-operative discomforts and complications, and shortens the period of disability due to the operation.

For more than three years I have attempted to employ this method in every operation. In the majority of cases I have a complete record of the pulse and blood pressure before, during, and after the operation, with notes on the behavior of the patient in relation to the operative manipulations.

Fig. 1 represents the anaesthetic chart now employed. In the central column the pulse and blood pressure are recorded every five or ten minutes; the respirations are also recorded in their proper place. In the column to the right the one in
charge of the anaesthetic chart notes from the dictation of the surgeon the various manipulations, for example: skin incision, peritoneum opened, mesentery pulled on, division of stomach, etc. In the left-hand column there is noted from dictation by the anaesthetist or by the surgeon the condition of the patient and any change in the method of administration of the anaesthetic, for example: gas started, infiltration with novocain; patient quiet; color good; patient cyanotic, moves, struggles; vomits; gas off; 20 drops of ether given; morphine hypodermically gr. 1/10; subcutaneous infusion of salt; strophanthin intravenously, etc.

Thus we obtain a graphic record of the effect of the definite operative manipulations on the pulse, blood pressure, respirations and condition and conduct of the patient during the operation.

These will be discussed more in detail.

From my observations I am convinced that any operation performed under this method of anaesthesia, properly carried out, will result in less shock; the mortality will be lower; the post-operative discomforts and complications will be greatly reduced, the period of disability very much shortened. All this has certainly been accomplished in my own experience, and I think I have convinced my associates, both surgeons and nurses, that this method has great advantages over ether. I am also confident that no operating surgeon will come to the same conclusions until he has faithfully given this method a fair trial over a considerable period of time.

It is important, in the first place, to emphasize here that success depends perhaps most on your technic of local infiltration. No surgeon, who has not performed many operations under local anaesthesia only, will be able to get the same results from the combined method. When the patient is awake and you attempt an operation under local anaesthesia, you will always be informed when a painful act takes place, and you will be surprised at the difficulty of making such an operation perfectly painless. Very few surgeons in this country have educated themselves in the difficult technic of
local infiltration. They are not familiar with the sensitivity of the different tissues and the varying degrees of discomfort following different manipulations. It is my opinion that the first step in the development of this new technic is to perform as many operations as possible under local anaesthesia.

Under nitrous-oxid-and-oxygen general anaesthesia the patient as a rule moves when any very painful step is performed, but there is no such reaction to the less painful manipulations, so that if you begin with general and local anaesthesia, you will be aware only of the more severe traumas and you will by no means block all painful afferent sensations. And, as the patient only moves and does not cry out, the surgeon will naturally be less influenced. The mere introduction of 1:400 novocain here and there will by no means accomplish the result.

When the patient is anaesthetized with ether or chloroform, he does not move when painful manipulations are made, and many surgeons are of the belief that such painful stimuli do not produce the same effect upon the nerve cell as when the patient is awake. A careful study of the blood-pressure records during operation and post-operative convalescence will dispel this belief. General anaesthesia apparently obliterates only the psychic shock which would ensue if the patient were awake. We have no proof that traumatic shock from painful wound insults is reduced by general anaesthesia, and the evidence is rather in favor of the contrary.

Theoretically the entire field of operation should be so blocked by local anaesthesia that the brain cells receive no sensory impulses. This is not possible in all operations, and for this reason a general anaesthetic becomes necessary. If one could completely block these impulses, and eliminate the fear of the patient, a general anaesthetic would be superfluous. The endeavor of the surgeon, therefore, should be to reduce the sensory impulses from the wound to a minimum.

The difficulty of proving that the combined method of anaesthesia lowers mortality, reduces post-operative complications and discomforts and shortens the period of disability,
is due to the fact that, in the first place, the records of many clinics are not sufficiently accurate and complete to allow a statistical study. In the second place, the mortality and other complications are relatively small for the majority of operations upon the average patient.

Even with rather bad ether narcosis and rough operative manipulations the mortality and other complications are not large when studied in the aggregate. With ether narcosis by the perfected method in the hands of an expert, and when the operation is performed by a skilled surgeon rapidly and without local anaesthesia, we have reason to believe that the mortality and complications are reduced.

The majority of surgeons apparently agree that, given the same operative skill and experience, the chances are better with ether as an anaesthetic than with chloroform, and still better when the ether is given by the perfected drop method and by an expert.

We must, therefore, compare this method of combined local and general anaesthesia with our results under the perfected ether method by a skilled anaesthetist, but without local anaesthesia.

For the ordinary operation upon the healthy individual the difference in mortality will be slight, but I am confident that a great difference will be found in the post-operative complications and discomforts and in the period of post-operative disability. The difference in the mortality from shock after grave operations upon healthy and upon handicapped individuals becomes very striking when these groups are studied separately. I am certain from my experience that the combined method of anaesthesia will reduce this mortality.

The mortality of simple and ordinary operations upon patients whose resistance before operation has been lowered by various factors, is by no means insignificant, and here I am also sure that the more difficult method of the combined anaesthesia will lower the mortality.

No statistics are available in the literature as to these facts. The investigation must at first be chiefly a personal
one. Each surgeon must familiarize himself with his own results in the different groups of cases and then see whether there is improvement when the operations are performed under a combination of nitrous-oxid-and-oxygen general anaesthesia and local infiltration with 1:400 novocain.

This brings me to the most important point in my discussion. In order to perfect this method of combined anaesthesia, it must be employed in every case, and then, after a large number of observations have accumulated, the surgeon will be in position to compare the results.

Every patient must be looked upon as handicapped and extremely ill. Every operation must be considered a grave one. Every detail of technic should be carried out conscientiously.

Surgeons will find that this requires time. The surgeon will either have to work more hours in the day, or perform fewer operations.

In my own experience I have observed, first, a most distinct improvement in the post-operative convalescence. Pneumonia, thrombosis and phlebitis, gas pains and distention of the abdomen, acute dilatation of the stomach, anuria and nephritis have become distinctly less frequent. Now, as a matter of fact, the graver of these complications were not very frequent after good ether anaesthesia. It is only when one studies the smaller group of handicapped individuals and the graver operations, that the difference becomes more evident.

The lessening of the ordinary post-operative discomforts which cannot be looked upon as grave complications is the most evident feature of the method of anaesthesia here advocated.

The proof that the mortality is lessened after operations under the combined form of anaesthesia is most difficult to furnish. I am quite confident that resection of the colon and stomach for ptosis and its complications will prove much less dangerous when performed under the combined method of anaesthesia and that the results as regards post-operative
mortality will improve very considerably. A study of fifty such cases of my own observation is in course of preparation and presents the available proof of my contention.

The various factors which enter into the question of estimating how to reduce mortality, post-operative complications and discomforts, and shorten the period of disability, are so numerous and each one so important, that it will not be out of place to mention them here. The mere substitution of nitrous oxid and oxygen for ether and the routine employment of local infiltration are by no means sufficient to alone accomplish the results hoped for.

The patient must be properly prepared—mentally and physically—for the operation. I have discussed this in a paper entitled: Estimation of the Vital Resistance of Patients with Reference to Possible Recovery after Surgical Intervention (Annals of Surgery, May, 1912).

The period of time between the onset of the disease and the operative relief is an important factor—in some cases the essential factor, and if this is not considered in the study of post-operative mortality, our conclusions may be misleading. For example, very early operations for intestinal obstruction under ether narcosis without local anaesthesia would probably show less mortality than late operations for the same condition under the most perfect combined local and gas anaesthesia. But my own statistics show that when we consider the cases of intestinal obstruction operated upon late, we will find that the mortality after ether narcosis is distinctly greater than after local anaesthesia alone, or combined local and gas anaesthesia. But even in this group another factor must be considered—whether enterostomy was performed or not. If the operator, with his improved method of anaesthesia, failed to perform enterostomy, while another with bad ether anaesthesia did, the latter's results would probably be better.

These examples show the importance of considering all the factors of safety when we attempt to get at the methods which yield the best results.

The condition of the patient before operation depends
upon many factors. As a rule the earlier the intervention, the better the results. I have attempted to show this in a previous communication (The Medical Aspects of Surgical Diseases, or Preventive Surgery, Jour. of Amer. Med. Assc., March 23, 1912, lviii, p. 829).

In conclusion we may sum up the question with the statement which apparently cannot be controverted, that there is a mortality, an increase in the number and severity of post-operative complications and discomforts, and a lengthened period of disability due to operative shock. The factors are psychic, due to fear; toxic and traumatic, due to the condition before operation; and psychic, toxic and traumatic, due to the operation itself. These factors may continue after operation.

There is no question that we wish to improve our results, and to accomplish this, all factors must be borne in mind.

The absolute proof that the substitution of nitrous oxid and oxygen combined with local anaesthesia for ether alone, will rest at first upon a personal investigation by the individual surgeon. We have not yet reached the stage when comparisons with the results of different surgeons will be as helpful, because as yet it seems impossible to get at all the factors which enter into the problem.

To obtain the best results, every surgeon must attempt to improve all of his methods, to get his patients earlier, to study more carefully the preparation for operation, to improve his general and local anaesthesia, to improve his own technic, to study and make better his post-operative treatment. Then, and only then, will he observe and be able to estimate the factor of the toxic shock from ether and the traumatic shock due to operation without local infiltration.

Fig. 1 is a chart made during the resection of the right half of the colon. The anaesthetic was gas and oxygen combined with local infiltration of 1:400 novocain; the full time of the operation was two hours and forty minutes. You will notice practically no change in the pulse or blood pressure; the patient's color was good throughout the operation. You will note that during the separation of the cæcum and colon,
when some tension was put on the mesocolon, the patient moved a little and there was slight locking of the jaws; the blood pressure rose slightly. When the transverse colon was divided with the Paquelin cautery, some slight tension was again placed on the mesocolon, and the patient reacted in a similar way. With these two exceptions the patient was absolutely quiet throughout the operation. Not a drop of ether was given. From the behavior of the blood pressure and the patient we can be quite confident that no very painful manipulations were carried out.

This patient had a greatly dilated duodenum due to a ptotic cecum pulling on the mesentery of the small intestine because of the shortness of the mesentery of the ileum near the cecum. She had been an invalid for seven years; gastric symptoms with vomiting had been present one year. She had lost weight, was anemic, very nervous; the kidney function, however, was unimpaired, and there was no evidence of a cardiac lesion. Here, therefore, we have a grave operation performed upon a somewhat handicapped patient. Her condition at the end of the operation

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**Fig. 1.**

<table>
<thead>
<tr>
<th>Anesthesia given</th>
<th>9.45 a.m.</th>
<th>Good color.</th>
<th>10.50</th>
<th>Anastomosis begun</th>
<th>11.05</th>
<th>Anastomosis finish at 11.50</th>
<th>Incision closed 12.00.</th>
<th>Time: 2 hours 40 min.</th>
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**Operation and Treatment.**

- Skin incision.
- Incision made 9.50.
- Pulling on stomach produces slight cyanosis.
- 10.00 locking of jaw.
- 10.15 separation of cecum and colon.
- Transverse colon severed.
- Closing begun 10.50.
- Anastomosis begun 11.05.
- Anastomosis finished at 11.50.
- Incision closed 12.00.
was as good as after an ordinary thirty-five-minute appendectomy performed under ether narcosis. I have discussed this lesion—chronic gastromesenteric ileus—in the *American Journal of Gastro-Enterology*, July, 1912.

Fig. 2. In this case the patient also suffered from a chronic gastromesenteric ileus; in addition there was pyloric stenosis due to a healed ulcer, requiring a Finney pyloroplasty in addition to the resection of the right half of the colon. You will note that the operation required three hours and twenty minutes; no ether was given; the patient took the gas and oxygen well, and local infiltration with 1:400 novocain was employed throughout the operation. The general condition of this patient was not as good as in the previous case: she had been bed-ridden for nine months and had existed on practically only buttermilk. She was extremely emaciated, with quite marked secondary anemia. The kidney function was good, and there was no cardiac lesion. You will note that during the Finney pyloroplasty, which was done with practically no tension, the pulse and blood pressure varied more than in the previous case.
during the first hour. This was due probably to the palpation of the
gall-bladder and investigation of the condition of the pancreas and duodenum. You will note that in the second hour, during the entire time
while the colon was being resected, the pulse and blood pressure showed
but slight variations. Even these slight variations, as compared with
those in the previous case, indicated to the operator that he was dealing
with a patient with but slight factors of resistance. This is shown on
the chart at the position of the first arrow. In closing the rent left in
the peritoneum after the removal of the colon, one has to handle most
sensitive tissues in an awkward position in the depth of the wound.
Although this required but ten minutes, you will note that the blood
pressure fell from 115 to 90. We then placed the patient in the Tren-
delenburg position and observed an immediate rise of blood pressure.
During the anastomosis of the ileum and colon the blood pressure re-
mained good, but just as we began to handle the wound for closure,
the blood pressure fell again, and the patient was given 1 mg. of stro-
phanthin into the vein. I have found that this drug is helpful to maintain
blood pressure, and I give it when the blood pressure falls below 100
and there is no reaction after lowering the head and giving subcutaneous
salt. You will note on the chart in this case that both of these measures
of protection had been employed. Just previous to this last fall in the
blood pressure the patient showed cyanosis, and for this reason the gas
was immediately discontinued and the remainder of the operation per-
formed under local anesthesia alone.

We have, therefore, in this case at the end of the opera-
tion, a moderate degree of shock from which the patient
gradually and completely recovered. When the operation
was completed on this individual she was relieved of a great
handicap—the pyloric stenosis, the duodenal dilatation, and
the toxæmia from the right giant colon. She could take and
retain nourishment almost immediately. There was no toxic
substance, such as ether, to be eliminated. From my experi-
ence, I would not have attempted this operation under ether
narcosis. I am confident that in this individual a rapid appen-
dectomy under ether would have been more serious than the
operation as performed, and her convalescence more uncom-
fortable. I look upon this case as an extreme test of the
method.

Fig. 3. This chart was made during an operation upon a male patient
in good general condition. The right half of the colon was resected be-
cause of post-operative adhesions secondary to appendectomy. The
patient suffered from pain and partial intestinal obstruction. When
there are adhesions about the colon it is more difficult to remove it without pulling on the parietal peritoneum, and it is very difficult to infiltrate large areas of this peritoneum. In this case this was apparently done successfully. The fall of the blood pressure to about normal as shown in the chart took place after all painful manipulations had ceased. The operation in this instance must have been painful, because you will observe that we had to give a little ether. Painful manipulations always at first increase the blood pressure. This patient, although in better general condition than the previous two, had a more uncomfortable convalescence which I attributed to the small amount of ether and the painful manipulations which we were unable to block. The details of this case will be discussed in a second paper already referred to.

I do not feel that I have as yet accomplished the utmost in the local infiltration of the posterior parietal peritoneum and mesentery in the operation for resection of the colon and stomach.

Fig. 4. This chart portrays three separate operations—each of these done entirely under local anæsthesia with novocain.
The patient was suffering from an advanced carcinoma of the larynx. The first operation consisted of the removal of the glands on the right side of the neck with the sternocleidomastoid muscle and internal jugular vein. All the nerve trunks coming out between the muscles of the neck were blocked. You will note that it was a long and tedious opera-

![Graph showing blood pressure changes during different stages of the operation.](image-url)
tion lasting four hours. The blood pressure in the first and last hour is not recorded, because the apparatus had to be used in another case. There was absolutely no post-operative shock, nor any complications. The record of the operation on the glands of the left side of the neck is complete—an identical operation with a similar result. The third operation consisted of the resection of the larynx performed without tracheotomy and with closure of the pharynx at the end. This operation was not absolutely painless, and you will note the fall in the blood pressure after the third hour. The shock was slight, and the patient made an uncomplicated recovery. The only handicap in this case was the almost occluded larynx. For this reason I did not use a general anaesthetic.

Fig. 5 represents a composite chart of three operations under novocain alone. The handicap of this patient was a marked arteriosclerosis with high blood pressure, a crippled heart with marked dilatation of the aorta, albumen and casts in the urine, and a low kidney function. The pulse and blood pressure in the first two operations were so nearly alike that they are here recorded together. These operations required about
one hour and forty-five minutes. You will note that in the third operation which required three hours, the pulse and blood pressure are lower. This may be explained from the fact that the patient, due to the rest and environment of the hospital had improved as far as his high blood pressure was concerned. The first operation consisted of the excision of a cancer of the mucous membrane of the cheek, the second of the removal of the glands under the left side of the jaw, the third of the removal of all the glands from mastoid to clavicle with the sternocleidomastoid and internal jugular vein.

Figs. 5 and 6 portray what is possible under local anaesthesia alone. Both patients had unusual self-control for local anaesthesia and desired to get along without a general anaesthetic because of the added danger.

My experience up to date with gas in high blood pressure has been most favorable, but not sufficient to test in this case (Fig. 6) if I could get along without it.

I shall reserve for a future communication the discussion of the apparent advantages of nitrous oxide and oxygen over ether in patients with high blood pressure.

Fig. 6. Here we have a graphic chart of shock due to trauma and loss of blood. This patient had a huge tumor beneath the psoas muscle in the left iliac fossa. It proved to be a benign fibromyxoma. He was taking 12 grains of morphine a day for pain when he came under my observation. I made up my mind to enucleate the tumor in stages, packing gauze between its capsule and the surrounding tissue. The chart was made at the last (tenth) operation. The final enucleation, you will note, required but twenty-five minutes. As the tumor was lifted from its bed there was profuse hemorrhage, and you will see the marked rise in the pulse and the fall in the blood pressure. Fortunately we were able to check the hemorrhage at once by packing. The patient recovered and is now well.

It seems unnecessary to reproduce here more charts. I look upon this paper as simply an introduction with the hope that it will influence you to try the method.

The final proof will rest upon a careful study of groups of operations of the same kind. These I propose to publish shortly. I feel convinced that I have sufficient evidence to prove that this method will be life-saving, if all the other
factors of safety are considered, in operations in the late stage of intestinal obstruction; in patients who have to be operated on while in shock after an injury; in the late stages of perforated gastric and duodenal ulcer, and in typhoid perforations; in resection of the stomach and colon for ptosis; in resection of the stomach for cancer and ulcer in patients weakened from prolonged pyloric stenosis; in the radical operation for cancer of the uterus; in the combined abdominal and sacral operation for cancer of the rectum. I think I can also show that the mortality will be decreased when less formidable operations are performed on patients handicapped with lowered kidney function, with sepsis, especially cases of cholangitis and jaundice; patients suffering with diabetes and
arteriosclerosis; high blood pressure from various causes; in the presence of pneumonia and bronchitis; in patients feeble with advanced age.

I have not, as yet, had sufficient experience with infants and young children. I feel that in these cases local infiltration should be employed, but we may find that ether given by the drop method is just as safe. Our limited experience with children is due to the fact that the number of cases is small, and we have not yet perfected the mask. My experience with operations under the combined anaesthesia on children between five and ten years of age is most satisfactory.
TUMORS OF THE CAROTID BODY*

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A body 5 millimetres long, 3 millimetres wide and 2.5 millimetres thick, lying in the bifurcation of the common carotid artery, of doubtful embryological derivation, of undetermined function, inconstantly present, but occasionally giving rise to tumors of a definite structure—that is the substance of our knowledge of this gland, so-called. Because of this uncertainty as to embryological derivation or physiological function, carotid body seems a better term to use than carotid gland.

Anatomy.—The carotid bodies are found in embryos of 20 to 30 millimetres long. They are variable in size, shape and position, and may be absent on one or both sides in embryo or adult. They increase in size as the individual grows, because of increase of connective tissue, blood-vessels and parenchyma. Reaching a certain size between 20 and 30 years, they remain stationary for a time and then the connective tissue only increases. The interlobular blood-vessels thicken, and sclerosis and atrophy results. The consistence of the carotid body varies, but usually it is moderately hard and elastic. In color it varies from a reddish-gray to a reddish-brown.

When present, the carotid body is found most commonly a little posteriorly to the bifurcation of the common carotid artery, lying between the internal and external carotids, and more closely united to one or the other of these. It is attached to the one on which it lies by the "ligament of Mayer,"

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through which it receives its blood supply. The body is surrounded by a dense fibrous (white and elastic) connective tissue capsule, from which prolongations are sent in, dividing the body into lobes, which are again subdivided into lobules. These delicate strands of connective tissue pass to the lobules and surround the "zell-ballen" of the Germans. These complete the alveolar arrangement of the structure, and are irregular groups of large, rounded or polyhedral cells, epithelioid in character, lying closely adjacent to the endothelial layer of the capillary tufts. They have a clear protoplasm, and contain large, round, well-stained nuclei. The afferent artery, running in the "ligament of Mayer," subdivides to pass to the lobes and lobules. Here it breaks up into a rich capillary network or tuft lying about and intimately associated with the "zell-ballen."

The nerve supply is abundant and is connected with both the cranial and sympathetic systems. It receives branches from the vagus and glossopharyngeal, superior laryngeal, and superior cervical sympathetic ganglion. Fibres pass from the vagus, glossopharyngeal and sympathetic to form a plexus in the angle of bifurcation just in front of the carotid body. Many fibres from this plexus penetrate the capsule of the organ. The capsule contains both medullated and non-medullated fibres, and these pass in freely to the glomerular tufts and "zell-ballen." Ganglion cells are scattered and few in number.

Embryology.—That the carotid bodies are derived from the sympatho-chromaffin system anlage, which buds off from the central nervous system in embryos of 20 to 30 millimetres, is the view expressed by Zuckerkandl. He says: "The glandula intercarotica is associated with the plexus intercaroticus. That it belongs to the chromaffin system was recognized by H. Stilling... Any attempt to derive this gland from a branchial pouch or from a thickening of the wall of a vessel must fail, since chromaffin cells can only be produced from sympatho-chromaffin tissue... A. Kohn derives the chromaffin elements of the glandula inter-
carotica from the nerve anlage which passes from the upper cervical sympathetic ganglion between the two carotids. In a 44 millimetre pig embryo he finds in this plexus ganglion cells, some of which have a large and feebly staining nucleus, and believes that these latter cells represent the specific elements of the carotid gland. Up to this time only scattered observations have been made on the glandula intercarotica in man. R. Paltauf investigated an embryo of 15 millimetres and a foetus of 45 millimetres. In the former the gland had not yet appeared, but it was present in the latter. According to Kohn, the cells of the anlage of the gland in a 19 millimetre (N. L.) embryo resemble neither the small, deeply staining ganglion cells of the intercarotid plexus nor the chromaffin cells. McMurrich, Bailey and Miller, and Heisler agree with this view as to the derivation of the carotid body. Keith does not definitely commit himself, but suggests a derivation from the sympathetic nervous system.

Of historical interest is the view, supported by Steide, Rabl, de Meuron and others, that they are derived from the third or fourth branchial cleft; and the later view of Kastschenko, Paltauf, and Monckeberg and others, that they are derived from the perithelium of the carotid arteries.

The above view of Zuckerkandl is strongly supported by Stilling's demonstration of cells in the "cell balls" and in the stroma cells which stain brown with neutral salts of chromic acid. Kohn confirmed Stilling's observation and calls these "chromaffin" cells. Similar cells are found in the medulla of the adrenal, in the pituitary and in the ganglia of the sympathetic nervous system. This group of structures, including the carotid bodies, is referred to as the "chromaffin" system.

Physiology.—As to the physiology of the carotid body there is but little positive knowledge. All investigations have proceeded along the line suggested by Stilling's demonstration of chromaffin cells in its substance. As the type of the chromaffin system, the suprarenal capsule, has to do with the regulation of blood pressure, as judged by its extract, the in-
vestigations into the function of the carotid body have been conducted along that line. Mulon, in 1904, prepared a watery extract of the carotid bodies of horses. With this, by injecting it into the veins of rabbits, he was enabled to produce a rise of blood pressure, and sometimes an acceleration of the force and rate of the heart beat. Gomez, working in 1907 and 1908, prepared a glycerin extract of carotid bodies. With this he produced a fall of blood pressure in cats.

Frugoni, in 1911, 1912, and 1913, prepared an extract of carotid bodies of young sucking calves in Ringer's solution, 4 c.c. of which was equivalent to the carotid bodies of a calf. By injecting this into the veins of rabbits, he was able to certainly cause the death of a rabbit of medium size with 4 to 6 c.c. Death occurred in about five minutes, and the pre-lethal symptoms were inconstant convulsive seizures, respiratory paralysis, arrest of circulation, and hyperemia of internal organs (anaphylaxis?). Intravenous injection of non-lethal doses caused a slight initial rise of blood pressure, followed by a fall of 20 to 30 millimetres of mercury. These phenomena are accompanied by feeble respiration and weak pulse. The same effects were obtained after severing the vagus and other depressor nerves. With isolated organs he was able to demonstrate a vasodilator effect. On the whole, he doubts the existence of an important internal secretion.

Its not constant presence, the contradictory results of experimental work, and the lack of clinical observation, indicate that the function, whatever it may be, is not important. However, the different parts of the chromaffin system, while of common embryology, possess different functions. Thus, the medulla of the adrenal affects blood pressure, the cortex has to do with the development of the sexual apparatus, the pituitary seems to exert a trophic influence, etc. These varying functions of the different parts of the chromaffin system, together with the fact that the carotid body atrophies at or soon after puberty and full body development, suggest that when its function is established it will be in some way connected with trophic stimuli in body development.

Pathology.—Pathological studies on the carotid bodies
are limited to the tumors, of which 60 have been reported, including the one described at length in this paper, and four cases furnished by prominent New York surgeons. Gomez observed some cases of sclerosis of the body, particularly in cases of arteriosclerosis, but this was not more marked than the change in the intima of the arteries in other locations. I have recently had an opportunity of observing a case of tumor of the carotid body occurring in the service of Dr. John Edmund MacKenty, at the Manhattan Eye, Ear and Throat Hospital, where the patient applied for relief from the throat symptoms. These observations and the study of the case form the basis of this paper.

**Clinical History.**—The patient, P. McD., male, Irish, driver, aged forty-one, presented himself at the clinic on January 14, 1913, for a tumor of the neck, with aphonia and difficult breathing, pain in the throat and difficult swallowing.

The family and past history were negative. The present illness began four months previously with loss of weight and increasing weakness. Six weeks previously he had noticed a hard tumor on the right side of the neck. The subjective symptoms had been noticed three weeks previously. In the four months he had lost twenty pounds in weight and had been compelled to give up work on account of weakness.

**Examination.**—Patient was a large robust man of 170 pounds. There was no marked evidence of cachexia. On the right side of the neck a hard tumor extended from the level of the angle of the jaw above to the clavicle below, and from the thyroid gland internally well into the posterior triangle. On palpation this tumor was board-like in hardness, there was no pulsation, and it was not movable in any direction, although the skin was freely movable over it. Auscultation over the tumor did not show any increase in the carotid bruit. Laryngeal examination showed paralysis of the right cord, and the larynx was displaced to the left. The chest was negative; pupils equal and reacted to light; no involvement of the facial nerve. The Wassermann and Noguchi reactions were negative.

He was sent to the hospital and a fragment of the tumor removed for diagnosis. In the laboratory this was divided into
two parts, one of which was hurried through the fixing solutions, the other being carried along slowly to secure more perfect fixation. The first part, cut into thick sections, showed a lymph node, much of which was normal or nearly so in structure. In places where the capsule was absent there was a definite infiltration of the surrounding fatty tissue with small, dense, closely packed round cells. From this appearance, and the definite, sarcoma-like tumor, a diagnosis of probable lymphosarcoma was made. The second piece, which was not sectioned until after operation, revealed a structure such as will be described below.

On the basis of this report the patient was readmitted to the hospital on January 23 for operation. The incision was carried along the anterior border of the sternomastoid from the angle of the jaw to the clavicle, and along the superior border of the clavicle to the trapezius. The skin, superficial and deep fascia, and the sternomastoid, were reflected in one flap. Raising this flap revealed a tumor extending from the upper border of the hyoid bone above down to and under the clavicle below. Anteriorly it was in contact with the thyroid gland, while posteriorly it extended to the transverse processes of the cervical vertebrae. Roughly the tumor was 14 centimetres long by 10 centimetres wide. The neoplasm was covered with a fibrous capsule. The surrounding tissue was adherent to the capsule, however, so that the line of demarcation was not sharp. It was lobular, dense, slightly elastic, friable. In color it was reddish-gray to red on section. An attempt was made to dissect it up from behind, but the growth was found to include the common carotid artery, internal jugular vein, pneumogastric and recurrent laryngeal nerves, and this attempt was abandoned. An incision was then made in the course of the common carotid artery and down to the artery and sheath, and an attempt was made to dissect the mass away from these structures. The neoplasm was so firmly adherent, however, that this was impossible. The portion of the tumor anterior to the vessels was then dissected away; hemorrhage, which had been free and troublesome, but not dangerous, was checked, drainage inserted and the wound closed. The exposed common carotid was irregularly eroded and had the appearance of a badly rusted iron pipe.

Recovery from the anaesthesia and post-operative shock was rapid and complete. There was no increase of laryngeal paral-
ysis, and no lung complications. The patient did well until January 30, when erysipelas intervened, with wound infection. There was rapid sloughing of flaps, with destruction of tissue, and the patient continued to grow weaker. On February 8 there was a slight hemorrhage from the wound. On the 9th a more severe hemorrhage necessitated tight packing, and there was a continuous troublesome oozing. On the next day the patient was taken to the operating room to stop the bleeding, which now had become serious. When the packing was removed and the wound opened there was a violent hemorrhage. A finger was inserted into the bleeding point to stop the hemorrhage and it entered a hole in the common carotid. Ligatures were placed below and above the bleeding point. An intravenous infusion of 1000 c.c. of saline was given and the patient returned to the ward. The next day, February 11, the patient suffered from a left-sided paralysis, was comatose, and gradually weakened till death on February 13, three weeks after the operation.

Pathological Findings.—The tissue sent to the laboratory was an irregular, torn mass half as large as a man's fist. In color it was red to reddish-gray. The torn surface presented a succession of lobules, appearing much like a mass of fish-roe. Extending over one side was a dense capsule, but no lobed appearance was visible. The specimen was hardened in formalin and alcohol, and embedded in celloidin and paraffin. Sections were stained with hematoxylin and eosin.

On microscopical examination the sections presented along one side a thick connective tissue capsule, with connective tissue bands extending from this into the depth of the tumor. These bands divided and subdivided, forming an alveolar structure. The connective tissue cells of these septa and of the capsule were long spindle-cells of sharp outline, with a lance-shaped, slightly vesicular nucleus. Scattered through these bands in groups were many younger connective tissue cells, without definite cell body, and with oval, vesicular nuclei.

The vascular supply of the tumor was abundant but anomalous. At no place were there well-formed blood-vessels, but the appearance was rather a succession of new formed blood spaces. Those running in the connective tissue stroma had a poorly defined vessel wall and were lined by irregular, jagged endothelial cells. Those in more intimate relationship with the alveolar part of the neoplasm presented only the endothelial lining, and the picture was the same as will be described in connection with the alveoli. Capillaries were present everywhere in the tumor, but were particularly abundant in those parts of the new growth which were richest in fibrous bands and septa. Many of the smaller
Composite drawing of typical fields of the tumor. A, blood space in intimate relationship with the cells of the alveoli; B, embryological remnant of gland; C, newly formed connective tissue cells making up the trabecula; D, vesicular cells filling the alveoli.
Microphotograph of tumor of the carotid body. Magnified 120 diameters.
blood spaces and capillaries had only a thin membrane between the lumen and the cellular elements.

The alveolar arrangement varied in different parts of the tumor. In places near the capsule the alveolar structure was regular and definite, while in older parts of the neoplasm this shaded off to a more diffuse, sarcomatous appearance. Some of the cell groups were round or irregular in shape, while others appeared as columns of cells. But always, due allowance being made for the variations present in malignant growths, the structure was the same. The relationship between the tumor cells proper and stroma was definite and intimate, fibrils seeming to pass from the stroma between the cells of the alveoli, and in places fibrils seemed to pass out from these to join the stroma. The cells in the alveoli were large and irregularly polyhedral. The centrally placed nucleus filled but a small part of the cell. The nucleus was round or oval in shape, was vesicular, possessed a prominent nuclear membrane and a well-marked nucleolus. About this was a fibrillar network of protoplasm. From the angles of these polyhedral cells fibrils seemed to pass between adjoining cells and into the stroma. The size of these cells varied, but not more so than is usual in rapidly growing neoplasia. Evidences of mitosis were present in both stroma and the enclosed cell groups, but more frequent in the latter. Some of the alveoli seemed to be grouped about or were intimately related to the blood spaces. In such places there was a layer of intimal cells. Outside of this were one or two layers of smaller spindle-shaped to polyhedral cells and then the alveolar cell nests. Within and between the cells of the alveoli were many vacuole-like spaces. Those within the cells were doubtless artefacts of fixation, but those between the cells present some evidence of being blood spaces. Monckeberg pictures them as such, but I think in my preparations the evidence was not conclusive. Whether his sections presented clearer pictures of this than my own, I am unable to say.

Occasionally, there were small areas of the tumor resembling the embryological carotid body. These consisted of wide blood spaces without walls, within which were columns of polyhedral cells. These resembled in structure the columns of cells and blood spaces of the liver, except that in proportion to the cells the blood spaces were much wider.

On the whole, the appearance was that of an endothelioma, but in places the structure was that of a loose sarcoma. The sections were variously diagnosed by competent men as carcinoma, sarcoma, endothelial sarcoma and endothelioma. This latter agreed with my own opinion, but I was never quite satisfied. When I took sections to Prof. James Ewing, of Cornell University Medical College, he suggested a tumor of the carotid body. Comparison of the structure of the tumor in this case with other reported tumors of the carotid body convinced me of the correctness of this diagnosis.

The Literature.—American literature on the carotid body begins with the careful paper by Keen and Funke in 1906.
Previous to this Charles L. Scudder, of Boston, reported a case of tumor of the carotid body in 1903, and Funke and McPhatter each one in 1904. Keen and Funke collected 27 cases in the living and two cases which had been discovered at autopsy. I have been able to collect 31 additional cases, 28 cases in the living, one examined at autopsy, although known to exist before death, and two discovered at autopsy. These are, numbering consecutively with Keen's cases, as follows:

30. Cecca. The patient, a man forty years of age, about four years previously had begun to notice a small pulsating tumor in the right carotid region. This slowly attained the size of a hazel-nut. There was an autopsy, as the man died of pneumonia. The tumor was found to be inclosed in a thick fibrous capsule, lying at the bifurcation of the common carotid, and was closely connected with the common carotid by a vascularized pedicle. The microscopic examination showed the tumor to be a primary angiosarcoma, which had developed at the expense of the carotid body.

31. Rivet. A woman, forty-nine years old, seven years previously had first noticed a swelling the size of a hazel-nut, at the level of the jaw, behind the ascending ramus. It was not painful, but had recently grown to the size of a turkey's egg. The skin over it was movable, and the pulsations of the external carotid could be felt through it. At operation the tumor was dissected away from the carotid arteries. There was free hemorrhage, and after the operation there was aphonia and difficulty in swallowing. The removed tumor had the appearance of a goitre, but on consulting the literature it was identified as a tumor of the carotid body. The clinical diagnosis had been a parotid tumor or aberrant thyroid.

32. Cook. The patient, J. W., a mulatto, aged 29, had a slowly growing, painless lump on the side of his neck. This was a large mass extending from the tip of the mastoid to the level of the cricoid cartilage, and from the side of the thyroid gland to within 1.5 inches of the ligamentum nuchae. The mass had a peculiar, elastic feel, was slightly compressible but not movable, and had a pulsation synchronous with the heart beat and expansile in all directions. A harsh bruit was heard over the left common carotid, beginning beneath the clavicle and extending to the tumor, while over the tumor a softer murmur was heard. At the operation hemorrhage was troublesome from the beginning, there being a constant oozing which could not be controlled with haemostats. The carotid arteries and internal jugular vein were ligated, but this did not control the hemorrhage. The patient died within an hour of the operation. The removed tumor was 7 x 5 centimetres in size. Only in places was there a definite capsule. It was dark red on the surface;
TUMORS OF THE CAROTID BODY.

on section, pearl gray tinged with red. The clinical diagnosis was probable carotid aneurism.

33. Cathcart.—The patient, a white male, aged thirty-three, was operated on two years before the case was reported. When first seen there was a firm, movable tumor on the left side of the neck the size of a pigeon's egg, but two months later this had increased to the size of a hen's egg. This mass was not tender and he complained of no pain. There was some interference with swallowing, and he was deaf on the left side. At the operation there was free bleeding from the whole exposed surface, and as this could not be controlled it was found necessary to ligate the common, internal and external carotids. This new growth extended from half an inch below the bifurcation to two inches above, and surrounded all three arteries. The tumor and arteries were removed intact. As the jugular vein and pneumogastric nerve were not involved these were not injured. There was a well-developed fibrous capsule sending septa within the structure, dividing it into alveoli-like spaces. There was no recurrence in two years. No diagnosis was made previous to operation.

34. Zondek.—In the case of a man sixty-three years of age a tumor had been noticed for nine years. It was on the right side of the neck at the level of the larynx. The swelling, which surrounded the common carotid at its bifurcation, gave rise to no symptoms, aside from a slight sensation of pressure. At operation the carotids were all ligated and cut. The patient made a good recovery, and was discharged three weeks after operation.

35. Licini.—A man, aged twenty-eight, had a tumor on the right side of his neck for nine years. After the tumor had existed for five years, under the impression that it was an enlarged gland, the pulsating mass was incised. There was free hemorrhage and a diagnosis of angioma was made. As the tumor continued to grow, and caused pain and dysphagia, the patient travelled from his home in Brazil, to Kocher, in Berne, Switzerland, to be operated on. On the basis of its location in the bifurcation of the common carotid artery, which could be traced through the tumor by palpation, and on the pulsation and elasticity, Kocher made a diagnosis of tumor of the carotid body. A tumor the size of a hen's egg was dissected out of the angle of bifurcation, which had been much widened by its growth. It was bluish in color and had the appearance of a soft sarcoma. The patient made a good recovery. On the basis of the histological findings it was called a "struma" of the intercarotid gland.

36. Beitzke.—This case of tumor of the carotid body was found accidentally at the autopsy of a woman fifty-six years of age. It had caused no symptoms during life, and the woman's death was due to severe general pemphigus complicated by pneumonia. A brownish-red tumor the size of a plum, of moderately solid consistence, was found in the angle of bifurcation of the left carotid artery. It was surrounded by a fibrous capsule, and was closely applied to the branches of the carotid, which showed no changes aside from a few yellowish spots,
the size of a lentil, on the intima. Upon the basis of the histological
findings, the author proposes to designate this form of tumor as "struma
of the carotid gland," or "struma intercarotica."

37. DOUGLAS.*—A. E., female, aged twenty-three years, American.
The tumor was painless, but increased slowly in size. There were no
symptoms until one week before operation, when hoarseness developed.
He found a mass 3.5 x 2.5 x 1.5 centimetres on the right side of the neck
at the anterior border of the sternomastoid muscle. This was firm,
smooth and freely movable laterally but not vertically. The skin was
freely movable over the tumor, it was not tender, and a slight trans-
mitted pulsation could be felt. At operation this tumor was found in
the bifurcation of the common carotid artery. The capsule, which was
exceedingly vascular, was adherent to the sheaths of the vessels, but was
removed without injuring them or any of the nerves. Paralysis of the
left vocal cord followed the operation, but recovery was complete. The
clinical diagnosis before operation was tuberculous cervical lymph gland.
The pathological diagnosis, by Dr. Norris, of Bellevue Hospital, was
perithelioma of the carotid body.

38. COLEY AND DOWNES.*—The patient, a man thirty-five years of age,
four months before admission to the hospital noticed a swelling in the left
sternomastoid muscle near its insertion. There was some difficulty in
breathing while sleeping, and during the last two or three days there
had been pain, in the muscle rather than in the tumor. Examination
showed a tumor the size of an egg, on the left side of the neck, just
internal to the angle of the jaw and apparently lying beneath the upper
portion of the sternomastoid. It was smooth and symmetrical in outline,
firm in consistence, and not tender. Examination of the pharynx showed
a similar swelling on the left side nearly as large as the external tumor,
pushing the tonsil and uvula over to the right side. At operation the
external carotid and several branches were ligated. The tumor, exceed-
ingly friable and matted to surrounding structures, was removed piece-
meal, partly with a curette. The vessels were distorted, soft, and eroded.
Recurrence took place promptly, and death occurred after four months.
The removed tumor was of an alveolar type, and very malignant, causing
death in eight months from the time it was first noticed.

39. COLEY.*—L. P. F., male, aged fifty-three, had a small tumor in the
left parotid region for six years. This tumor, hard, painless, slightly
movable, caused no inconvenience. As the tumor seemed to be getting
larger and less movable, an operation for its removal was performed
March 30, 1906. The deeply situated mass was enucleated, carrying with it
the buccal branch of the facial nerve, which was entirely embedded in
the growth. Paralysis of the buccinator and levator anguli oris occurred
on the day following the operation, succeeded soon afterward by inability
to close the left eye, and a little later by difficulty in pronouncing the
letter "p." Later there was almost complete paralysis of the facial nerve
and some branches of the fifth. The tumor recurred locally, followed by
death in eight months with symptoms of brain involvement. Microscopi-
cally the tumor is described as a "a sarcoma of the mixed-cell variety.
A great part of the tumor is made up of fibrous tissue, which more or less surrounds the sarcoma cells. In the centre of the sarcomatous areas are patches of degeneration. The alveolar arrangement of the large sarcoma cells lead one to conclude that their origin is from the tissue surrounding the blood-vessels."

40. Green. —Miss A., aged seven, had a tumor the size of a pullet's egg on the right side of the neck, just beneath the sternomastoid muscle, on a level with the bifurcation of the common carotid artery. It had been growing very slowly for two years, but gave rise to no symptoms. The tumor was removed by ligation of the three carotids, which it involved. This was followed by right sided paralysis, from which she never entirely recovered. The tumor was very vascular and bled freely.

41. Green. —Mrs. B., aged forty-five, had had a slowly growing tumor on the side of her neck for 17 years. It was lying beneath the anterior border of the sternomastoid muscle, was movable, elastic, and slightly pulsating. At operation it was found to extend from the angle of the jaw to near the clavicle. It was bluish in color and very vascular, bleeding freely whenever injured. The carotids were surrounded and the internal jugular vein and pneumogastric nerve were attached to its surface. As removal would have involved ligation of all the carotids and the internal jugular vein, with probable injury to the pneumogastric, hypoglossal, glossopharyngeal and descending noni nerves, it was left in situ. The clinical diagnosis had been a vascular tumor. Neither of Green's cases were examined histologically.

42. Makara. —A boy eighteen years old, had, two years previously, first noticed a small tumor on the right side of his neck. At the time of operation this had reached the size of a pigeon's egg, and interfered with swallowing. The tumor was excised by ligation of the common, internal and external carotids, the jugular vein and nerve trunks being preserved. On the second day after operation the patient developed fever, promptly followed by hemiplegia and dysphagia. Death resulted on the third day from softening of the brain due to interference with the blood supply. The removed tumor was 4 x 3.2 x 3 centimetres, enclosed in a fibrous capsule. Histological examination showed the usual alveolar structure of a tumor of the carotid body. The clinical diagnosis had been an accessory thyroid.

43. Alezais and Peyron. —These authors report a case of malignant degeneration of a tumor of the carotid gland. The tumor, discovered at the autopsy of an adult, was adherent to the three carotids, the internal jugular vein, and the aponeurotic muscular sheaths. In places there was the ordinary perithelial type of neoplasms of the carotid gland; in other places a tumor of the type of pavement epithelium, tubular or lobulated. The two types were intermingled, but the first type was more abundant near the periphery, while the second type was more abundant in the deeper parts. The cortical layers contained areas showing transition from the usual type of carotid gland tumor to the epithelial type.
44. Kuznetsoff. — A female, aged forty-eight, had a right-sided tumor which had existed for two years, and which grew rapidly in the past six months. There was a swelling the size of a walnut in the course of the common carotid artery, which was movable laterally but not horizontally. She suffered occasionally from sticking pains. The patient was operated on in 1907. The external carotid was ligated, the tumor being dissected away from the other carotid arteries. The removed tumor was encapsulated, and was the size of a large plum. Recovery was complete without complications. The clinical diagnosis was between a cervical lymph adenitis and a tumor of the carotid gland.

45. Ligin. — Kuznetsoff refers to a case in which he assisted a Dr. Ligin to remove a tumor from a young soldier. It had been necessary to resect all the carotids. He classes it as a tumor of the carotid gland with recovery.

46. Dobromisloff. — A male, forty-one years old, had a left-sided tumor for 17 years, with rapid growth for one year. This tumor was in the superior carotid triangle. It was operated on in 1900 by Salisheff. All three carotids were ligated and removed. The internal jugular vein and pneumogastric nerve were cut. The tumor grew about the common carotid artery, and when removed it was egg-shaped, 7 x 5 x 4 centimetres in size, very firm, reddish-gray on section. It had been diagnosed as a tumor of the thyroid gland. Death occurred one day after operation.

47. Dobromisloff. — A female, aged twenty-five, had a tumor on the left side of her neck for seven years. Two years previously it had taken on rapid growth. It was located at the bifurcation of the common carotid, beneath the sternomastoid muscle, and extended up to within a finger's breadth of the lobe of the ear. The larynx was displaced to the right. There was transmitted but not expansile pulsation. Lateral movement was free, but vertical movements were restricted. At operation, in 1906, many veins were ligated and the arteries dissected out. While the posterior portion was being dissected hemorrhage was free. It was an encapsulated tumor 9.5 x 8 centimetres. The patient recovered, but the left pupil remained dilated and the conjunctiva injected.

48. Woolley and Fee. — A woman, sixty-eight years old, had suffered from goitre five years. Two years ago she noticed a tumor on the right side of her neck. When examined it was 2.5 inches long by 1.5 inches wide. The larynx was pushed to the left. When the patient was examined on her back a bruit was heard over the tumor, but when her face was down this disappeared. There was a transmitted but not expansile pulsation. Vertical movement was free, but there was no horizontal movement, as the tumor was attached to the thyroid gland. The consistence was that of a large, non-pulsating lymph gland. At operation the tumor was removed, together with the bifurcation of the common carotid artery. The removed tumor was 6.5 x 3 x 3 centimetres and weighed 35 grammes. On microscopic examination there was distinct evidence of a sarcomatous change occurring in the tumor.
The patient did well for a while after the operation, but died 23 days later from an apparent septicemia.

49. Sinushin.—In a paper read before a Moscow medical society Sinushin refers to a second case coming under his observation. The patient was a woman forty-eight years old, and the report was made two years after the operation. There were no symptoms other than a gradually increasing swelling. At operation a typical tumor of the carotid body was found in the bifurcation of the common carotid artery, pushing the branches wide apart. The data given is very meagre, but gross and microscopic photographs leave no doubt as to the nature of the growth.

50. Chiari.—The patient, a man thirty-nine years of age, had noticed a tumor the size of a hazel-nut on the left side of his neck three and one-half years previously. It was smooth, freely movable, and the only symptom was a slight burning sensation. After a few months' duration it began to grow slowly, and about once a week he had attacks of pain radiating to the left side of the chest. As the tumor continued to grow these attacks became more frequent, often occurring several times in the 24 hours, and the pain became so intense the patient was unable to work. On examination Chiari found, in a position corresponding to the bifurcation of the common carotid, a hard smooth tumor the size of a pigeon's egg. It was only slightly movable, and a transmitted pulsation could be felt through it. At operation the tumor was matted to the surrounding tissues. The external carotid was ligated, and the descending branch of the hypoglossal nerve divided. The tumor was then dissected away from the internal carotid and lifted out of the widely distended angle of bifurcation. Microscopical examination revealed the usual structure of tumors of the carotid body. He rejects the idea of a hyperplasia of the normal gland, as not all the elements of the normal structure enter into the tumor formation. Notable is the absence of ganglion cells in the tumor.

51. Hollaender.—On May 22, 1912, Hollaender demonstrated a tumor of the carotid body before the Berlin Medical Society. The tumor, the size of an egg, had occupied the upper triangle on the left side of the neck of a young actress. The only complaint of the patient was the disfigurement, but on examination a mild exophthalmus was observed. The larynx was displaced to the right. At operation the tumor was found to surround the external carotid, but was dissected away from it and the widened angle of bifurcation without sacrificing either of the carotids or any of the nerves. A mild disturbance of the recurrent nerve persisted for several days, but disappeared completely. No diagnosis was made previous to operation.

52. Randisi.—The patient, a woman fifty-five years of age, nine years previously had noticed a tumor on the right side of her neck, at the level of the thyroid cartilage. This swelling had very slowly increased in size, but aside from the deformity there were no symptoms. At examination there was a tumor the size of a lemon, of regular, rounded shape, and elastic on palpation. There was a faint pulsation, transmitted but not expansile. As aneurism and malignant growth could be ruled out from this history and the
examination, an operation was decided on. The tumor was found lying on the anterior surface of the carotid arteries, involving the upper two-thirds of the common and a considerable distance along the internal and external. Paralysis of the right vocal cord followed the operation, although there had been no injury of the recurrent laryngeal nerve. From the histological examination the author calls the tumor an angio-myxo-perithelioma.

53. Boni.—A woman, thirty-four years of age, four years previously had first noticed the presence of a small swelling on the right side of the neck. This was the size of a small nut, was free from pain, spontaneously or elicited by pressure, and it was on a level with the angle of the jaw. Four months before coming under observation this tumor began to enlarge, became painful, and the patient became conscious of pulsation. On examination a soft, elastic tumor the size of an orange was found, pulsating synchronously with the carotid artery. It was somewhat reducible on pressure, but did not fluctuate. The location of the tumor in the bifurcation of the carotid, its intimate relation with the artery, the pulsations of which it transmitted, suggested a tumor of the carotid body. The tumor was removed by ligation of the common, external, and internal carotids, the jugular vein and pneumogastric and sympathetic nerves being dissected away from it. There were no post-operative sequelae, and the patient remained well at the time of the report, two years after the operation. The histological examination suggested a fibro-haemangio-endothelioma. The author is in doubt as to the correct histological diagnosis, and leaves the question open as between a carotid perithelioma and a carotid adenoma.

54. Mathews.—The patient, H., a male, twenty-five years old when first seen, was unable to definitely fix the appearance of a tumor on the left side of his neck, but thought there had always been a fulness there. The history, however, was quite definite of a growth for three years. In recent months there had been a modification of the voice. Examination showed a man in fairly good health. There was a swelling under the left sternomastoid muscle, which was ill defined and extended upward to the jaw and base of the skull and downward to the thyroid cartilage. Over this there was a bruit synchronous with the carotid pulsation. Pressure over the carotid suppressed the bruit, but did not reduce the size of the tumor. The left tonsil protruded to the median line, was smooth, not inflamed, and hard. The left side of the tongue was paralyzed and atrophied. Dr. Mathews attempted an operation at the General Memorial Hospital on May 9, 1911. The external jugular vein was ligated, and some pieces were removed from the mass, which infiltrated the surrounding tissue, leaving no definite outline to the tumor. Venous bleeding was profuse, although the internal jugular was about empty. As removal of the entire growth would have required extirpation of the common, internal and external carotids and the internal jugular vein, with all the important nerves of that side, and probably also the lateral wall of the pharynx, the wound was closed, leaving the tumor in situ. Primary union followed. This patient visited Dr. Duncan
Dr. Lilienthal's first case. Endothelial tumor of carotid body, long standing. Note absence of cachexia.

Dr. Mathew's case. Microphotograph of section removed at time of operation.
MacPherson in the summer of 1913 for a growth in his left ear, which was removed at the Post-Graduate Hospital July 1, 1913. The operation was interfered with by the severe pulsatile bleeding. No histological examination was made of the growth, owing to loss of the specimen. Following a positive Wassermann, two injections of salvarsan were given with some apparent improvement. The patient continues to work as a street-car conductor, but has a contracted pupil on the left side and there is a stiffness of the neck. (Microscopical examination of a poorly prepared section from the mass removed by Dr. Mathews convinces me this is an undoubted tumor of the carotid body.) (Presented before the New York Surgical Society, October 22, 1913.)

55. DaCosta.—March 3, 1913, before the Philadelphia Surgical Society, DaCosta presented a specimen of a tumor of the carotid body, which he had removed from a woman thirty-six years of age. The tumor had been noticed 16 years previously, but growth had been slow until six months before operation. During this six months the tumor had grown more than in the 15½ years before that time. The diagnosis, made before operation, was based on the slow growth for years; the carotid pulsation, which lifted the tumor at every beat of the heart; the absence of expansile pulsation; the free movement laterally but not vertically. The tumor, the size of an English walnut, was removed by ligation of the external carotid, it being dissected away from the internal carotid and jugular vein. The pathological diagnosis was perithelioma.

56. Lilienthal.—A woman, M. C., about thirty-eight years old, was admitted to Mt. Sinai Hospital in April, 1906. Ten months before she had first noticed a tumor the size of a marble which at first increased slowly in size, but for ten weeks before admission had grown so rapidly that when she entered the hospital it was enormous, extending from the trapezius posteriorly across the median line in front. There were severe "neuralgic" pains in the head and there was hoarseness from paralysis of the right vocal cord. The tumor felt hard and solid but was not attached to the skin. There was no discoloration. On April 6, Dr. Lilienthal removed a specimen for examination, considering the case inoperable. On July 6, in order to relieve suffocative symptoms, Dr. Elsberg, his associate, attempted to extirpate the mass and succeeded in removing about half of it. She left the hospital about three months later, returning the following March with a huge fungating mass. She died the same month of repeated hemorrhages. Dr. Mandelbaum, pathologist to the hospital, examined the original specimen and also the larger portion which had been later excised. His report is hemangioma arising from perithelium. The cells are uniform, varying but little in size and appearance, thus differing from the usual type of malignant tumor.

57. Lilienthal.—October 8, 1913, before the New York Surgical Society, Dr. Lilienthal presented a case of tumor of the carotid body, with the following report: "This woman was presented by me in the spring of 1909 before this society. At that time she was fifty-six years old, and stated that she had had a small lump in the side of her neck for 30 years. For five years before she had consulted me this had increased considerably in size, and during one year it had grown rapidly, so that
she became alarmed. The diagnosis of tumor of the carotid body was made before the operation because of the hardness, the location, the long history, and because I had had the opportunity to examine a similar case, and afterward to operate on it, some years before. That patient died about two years after the operation of relapse with cachexia, but with no secondary or metastatic growths. The histological diagnosis, as in the present case, was made in the laboratory of Mt. Sinai Hospital. The tumor in my patient to-night was the size of an egg at the time of the first operation. There were firm adhesions to the internal jugular vein and to the carotid artery, so that it was necessary to ligate both of these vessels close to the clavicle, and using them and the freed tumor as tractors it was possible to shell out the pneumogastric nerve and ligate the internal and external carotid arteries and also the jugular vein in their upper portions. The day after the operation there was aphasia and well-marked right hemiplegia. The left eyeball was soft and its pupil contracted. In a few days all symptoms except the contraction of the pupil had disappeared. The pupillary contraction was probably due to injury of the superior cervical sympathetic ganglion. The aphasia was central. There was no aphonia. . . . DaCosta states that the apparent pulsation in these tumors is transmitted from the arteries. In the patient presented here to-night it appears to me that the tumor itself undoubtedly pulsates. I consider the case inoperable, and the patient now shows signs of cachexia."

58. GRAHAM."—A male, age twenty-seven, was admitted to Lakeside Hospital, Cleveland, October 27, 1906, with a tumor on the right side of his neck that had existed for ten years. The tumor, not visible but palpable in its early stages, was free from pain and discomfort, and had been discovered accidentally. There had been severe headaches, the eye had been inflamed and the pupil irregular. During the six weeks previous to admission to the hospital the patient had suffered from sharp, shooting pains radiating to the left ear. At the operation, by Dr. Crile, a tumor 5 x 4 x 3 was removed by ligation of all the carotids. The recurrent laryngeal and the superior cervical sympathetic nerves were divided. The hypoglossal nerve was adherent to the tumor and was deflected from its course. During the operation there had been free bleeding, difficult to control, and at its conclusion the patient was suffering from severe shock. The next day the left pupil was contracted and the left eye paretic, and the patient suffered marked hoarseness. Weakness of the calf muscles and the arm developed after ten days, but recovery was complete. There has been no recurrence to date. Histological examination showed the growth to be a tumor of the carotid body.

59. GRAHAM."—A male, aged twenty-seven, was admitted to the Lakeside Hospital March 12, 1913, with a diagnosis of tumor of the right tonsil. The tumor was known to have been present for seven years, and during that time it had not increased much in size. There was no pain and no difficulty in breathing or swallowing. The growth pushed far into the pharynx, reaching to the uvula. Externally it extended from the ear to the angle of the jaw, was smooth, round, and about the size of a small egg. It was slightly movable from side to side but not up and down. The right submaxillary glands were enlarged. Dr. Crile
removed the tumor, 5.5 x 4.5 x 2.5 centimetres, by ligation of the external carotid artery and internal jugular vein. A portion of the vagus was resected, the hypoglossal nerve laid bare but not injured. After the operation the right pupil was contracted and irregular, and there was marked hoarseness. Both these conditions were present at the time of discharge, one month later. Histological examination showed a typical tumor of the carotid body.

60. Callison and Mackenty.—The case reported in this paper.

Recapitulation.—In the 60 cases of tumor of the carotid body four cases (28, 29, 36, 43) have been found at autopsy. Two (25, 30) were examined post mortem, although the existence of a tumor had been known when death occurred from other cause. The remaining 54 cases have come to operation. In four (41, 54, 56, 60) the tumor was laid bare, only to find such extensive involvement that nothing could be done. All three carotids were ligated in 32 cases, the external only in seven cases. In 15 cases the tumor has been dissected away from all the vessels, or dissected away from the common or internal carotids after ligation of the external. In eight cases recurrence took place, in six of these (5, 7, 14, 24, 37, 39) after the tumor had been dissected away from the blood-vessels, in two cases (38 and 57) after complete removal of all the carotids. In one case examined after death (26) there were metastases in the liver. Of the 54 patients operated on, 42 have recovered and 12 died. But to these twelve deaths must be added four from recurrence and six other speedy deaths in prospect from recurrences known to exist when the case was reported, or 22 deaths in 54 cases. In one other case the patient probably died as a result of the tumor. The causes of death have been: In cases 1, 6, 11, 23, pneumonia, in all of which the pneumogastric was divided or resected at the operation; in cases 3, 32, and 56, hemorrhage; in cases 22 and 41, cerebral anæmia; in case 27, acute oedema of the lungs; case 45, not stated; in case 47, septicaemia; in case 60, infection and hemorrhage.

In addition to this mortality, however, other accidents have arisen in the patients who survived. In cases 2, 12, 26 and 40 the patients have had hemiplegia with aphasia. In
four the voice has been affected, and there has been more or less dysphagia. In one there has been such tracheal irritation as to produce a constant cough. In five the tongue has deviated to one side. In four there has been an altered pupil, in one conjunctival injection. In four cases the face has been partly paralyzed.

Etiology.—The etiology of tumors of the carotid body is wrapped in the same obscurity that envelops the causation of other neoplasia. A study of the ages of reported cases seems to offer some justification for von Heinleth's\(^4\) observation that the carotid body reaches full development between 20 and 30, and then either atrophies or goes on to tumor formation. These ages, by decades, are: Up to 20 years, 3 cases; 21 to 30 years, 13; 31 to 40, 12; 41 to 50, 14; 51 to 60, 10; over 61, 5. In three cases the age is not stated. It is thus seen that in 57 cases in which the age is given, 39 occurred between the ages of 20 and 50. This is accentuated by a study of the duration of the cases. In the younger individuals, the duration is short, while in older persons the duration is of much greater length, 17 years in cases 39 and 45. The sexes are equally affected—31 males and 28 females, with the sex not stated in one case.

The Nature of the Growth.—These tumors usually have a long history of slow growth. During this period they may manifest the characteristics of a benign neoplasm. They are encapsulated, do not invade the surrounding tissues, do not return if completely removed, and give rise to no symptoms other than the deformity. Complete removal is, of course, difficult on account of their location. Later they may take on rapid growth and assume the characteristics of a mildly malignant tumor, recurrences and metastases being reported, but the cachexia and anaemia of a malignant growth are not present. Considering this history, and on the histological structure, Beitzke, in his case, and Kocher, in the case reported by Licini, designate the condition as a “struma.” Their uniform classification in one of the tumor groups is not possible because of the varying structure of the tumor in some of
TUMORS OF THE CAROTID BODY.

the cases. They have been most usually diagnosed as endotheliomata or peritheliomata. The structure of the case here reported is more closely allied to the endotheliomata than any other form of tumor. Leithoff, in the case reported by von Heinleth, and Woolley, in his own case, lay stress on the sarcomatous change occurring in the new growth. Alezais and Peyron describe a change in their tumor which seems to be carcinomatous. This is, so far as I have been able to discover, the only recorded case in which apparent epithelial change was present. Cecca reports his case as primary angiosarcoma. Until a more definite determination of their nature has been made, the best term to use in their diagnosis is simply "tumor of the carotid body."

Symptoms.—The symptoms of tumor of the carotid body are both subjective and objective.

Subjective Symptoms.—The patient may present himself at an early stage of the growth, because of the deformity, and desire cosmetic betterment; he may come at a later time, because of fear of the consequences of a rapidly growing tumor of the neck; or he may only present himself for relief from some of the symptoms caused by the progressive damage done by the tumor, as in the case here presented.

In the first case he will complain of no symptoms but the deformity of a tumor of the neck. There is no pain or tenderness, and he only asks for cosmetic improvement.

In the second and third stages the symptoms are due to involvement of the cranial and sympathetic nerves. The number and severity of the symptoms will depend upon the extent to which the tumor has grown. There may be difficulty in phonation or swallowing, or an annoying cough may be present. He may complain of deafness or conjunctivitis. There may be, at a late stage, some pain as nerve trunks are being included in the growth. On the whole, the subjective symptoms are surprisingly few.

Objective Symptoms.—The objective symptoms are more numerous and constant than the subjective. The findings on examination will vary according to the stage at which the patient presents himself. In the early stage there is a tumor
from the size of a robin’s egg to one that can just be palpated. It is underneath the sternomastoid, or at its anterior margin, on a level with the upper border of the thyroid cartilage. It is egg-shaped, single, discrete, firm, elastic, movable laterally but not vertically. There is a pulsation, transmitted but not expansile. A stethoscope placed over the tumor will reveal a distinct bruit in most cases. As the tumor progresses the picture changes, and more and more structures are involved. Perhaps the most constant of the later symptoms is the paralysis due to involvement of the recurrent laryngeal while its fibres are still within the vagus. These reveal themselves as paralyses of the cords and other laryngeal and pharyngeal muscles, leading to difficult phonation and deglutition. The larynx may be congested and catarrhal. The pupils may be irregular and fail to react to light on the affected side. When the tumor becomes more extensive and invades surrounding structures its mobility may be distinctly less. At this stage the larynx may be pushed to one side, or the tumor may bulge into the pharynx.

Differential Diagnosis.—The first difficulty in the way of making a diagnosis of tumors of the carotid body is their rarity. Were they more common the diagnosis would be comparatively easy. But when one is encountered its true nature is not suspected. Seven have been recognized before operation. These were by Reclus and Chevassu, Kopfstein and Maydl, Da Costa (two), Kocher in the case reported by Licini, Boni, and by Lilienthal in his second case. Kuznetsoff narrowed his tumor to a lymph adenitis or a tumor of the carotid body. Keen thinks he would recognize another one if it should come under his observation.

Tumors of the carotid body must be differentiated from cervical lymph adenitis, early metastatic carcinoma of the lymph glands, sarcoma, particularly lymphosarcoma and sarcoma of the lymph glands, lipoma, fibroma, aneurism, branchial cyst, gumma, Hodgkin’s disease, aberrant thyroid and Bezold’s perforation of the mastoid. It is only when these conditions occur in the superior carotid triangle that a differentiation must be made.
Cervical lymph adenitis is usually multiple, and as a rule these nodes invade the surrounding tissues and are matted together. They may be tender. Reclus says they are entirely hard or entirely soft. If the nodes attach themselves directly to the large arteries of the neck, and are very hard, there may be a transmitted pulsation. Finally, the history, with the subcutaneous tuberculin test, with its associated rise of temperature and aggravation of the local picture, may decide their nature.

In carcinoma the primary focus can usually be located, the nodes are usually multiple, are rapidly growing, of stony hardness, and later there will be increasing cachexia and anæmia. Carcinoma usually invades the surrounding tissues, so that motion in all directions is limited.

Sarcoma is rarely limited to one lymph node, but several closely connected glands will be involved. There is movement in all directions in the early stages, and no transmitted pulsation. Pulsation and murmur rule out lymphosarcoma, according to Kopfstein.

Fibromas are more superficial, harder, and more movable than carotid tumors, and are rarely found in this location. Should one occur, however, its differentiation would be difficult.

Lipomas have a woolly feel, are softer, more superficial and less uniform. They lack the pulsation of a carotid tumor, and are movable in all directions.

Branchial cysts are usually superficial, but they may reach to the deep structures of the neck. As a rule they are congenital. Fluctuation is usually present. After being satisfied that the condition is not an aneurism, aspiration will demonstrate the nature of a cyst, as either a light colored or cloudy fluid will be obtained.

Hodgkin's disease gives multiple nodes, movable, and is bilateral from the first. In density they are intermediate between malignant tumors and tuberculous glands. The nodes feel like lipoma, but are more deeply situated.

Syphilis of the glands gives an adherent, hard, matted
mass, and there is usually other evidence of syphilis. The Wassermann and Noguchi reactions will aid in the diagnosis, when positive, or a therapeutic test may establish the nature of the swelling.

Aneurism gives rise to an expansile pulsation, the pulse on the affected side is delayed in the temporal arteries, and there is a gurgling murmur over the tumor.

Kopfstein excludes aberrant thyroid by the absence of an enlarged thyroid gland. Reclus says he has never seen aberrant thyroid gland as high as the thyroid cartilage.

The differential diagnosis, hard as it is on paper, is yet more difficult in actual practice. After the surgeon has exhausted every diagnostic means at his command, he will still be in doubt as to the nature of the tumor he is considering. It then becomes necessary to remove a fragment of tissue for pathological diagnosis, or to proceed in ignorance of the nature of the growth with which he is dealing.

Surgery.—The detailed surgical treatment of tumors of the carotid body is beyond the proper bounds of this paper. Yet some suggestions from a pathological viewpoint may not be amiss. The history of this tumor shows it to be, in its early stages, a benign tumor, which later takes on a malignant growth. The surgical treatment, therefore, for purposes of consideration, can be divided into two cases. A diagnosis is rarely made in the early, benign stage, but an operation is attempted under some mistaken diagnosis, and then the true nature of the tumor is discovered. If now the tumor is not closely adherent to the arteries, except through the "ligament of Mayer," it seems safe to dissect it away from the bifurcation. Keen advises against this, but I can see no objection if a close watch is kept for recurrence and then such further operative procedures taken as the case may demand. On the other hand, if the tumor surrounds the arteries, is closely adherent to the wall, and other structures are included in the surface of the growth, then an attempt to dissect away the mass must be condemned. Five recurrences out of fifteen in which this has been attempted argue strongly against it.
The surgeon may now close up the wound, leaving the tumor in situ, as Green did; or he may remove the tumor and arteries together, the usual course pursued. This involves ligation of the common, internal and external carotid arteries, also probable ligation of the internal jugular vein, and the attendant danger of injuring the pneumogastric, hypoglossal and other nerves. The surgery now changes from that of a tumor of the carotid body to that of the carotid artery. As this is one of the most formidable and dangerous operations the surgeon is called upon to perform, each must decide for himself the course to be pursued.

In closing I wish to thank Drs. Mathews, Lilienthai, and Coley for the personal cases they have given me; Prof. Ewing for his suggestions as to the nature of the tumor; Dr. H. T. Brooks for suggestions in the preparation of the paper, and Mr. Wm. S. Dunn, of the Photographic Department of Cornell University Medical College, for furnishing the microphotograph used in the illustration.

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Personal communication from Dr. Wm. B. Coley, of New York. Case 38 is mentioned in the paper by Douglas.


TUMORS OF THE CAROTID BODY.

20 Personal communication from Dr. Frank S. Mathews, 62 West 50th Street, including case history and microscopic section from the nodes removed at time of operation.
THE EARLY DIAGNOSIS OF HYDRONEPHROSIS
BY PYELOGRAPHY AND OTHER MEANS.

BY J. W. THOMSON WALKER, F.R.C.S.,
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In dealing with a new and unfamiliar method of diagnosis such as pyelography it is not unreasonable to ask where the necessity for its use arises. To meet this question I shall preface my remarks by a short account of our means of diagnosis of hydronephrosis, and their practical value. Hydronephrosis, as we know it clinically, presents two stages in its development. There is a stage during which symptoms alone are present and a stage where a swelling is constantly or intermittently found in the loin.

I take it that when a large permanent swelling is present there can seldom be any remarkable difficulty in making a diagnosis, first, of a renal tumor and then of the hydronephrotic nature of the tumor, none at least which is not generally recognized and the salient points in the differential diagnosis of which are not worn threadbare by constant repetition. Diagnosis in this, the second stage, need not therefore concern us here.

Two questions do, however, arise in regard to this second stage of hydronephrosis, which have a very direct bearing on our subject. In the first place what amount of damage has the kidney sustained? In other words, what is the value of a hydronephrotic kidney? And second, if the obstruction is relieved will the kidney return to its normal state? Space does not permit of full discussion of these important questions, only the briefest reference to them is possible.

1. In the fully developed hydronephrosis the wall of the sac is reduced to half or one-quarter of an inch in thickness. In this the renal tissue is spread out over a large area and there is an advanced degree of interstitial nephritis.

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The functional value of such a kidney is greatly impaired. The percentage of urea is diminished. The following is the result of 8 examinations made in a case of movable hydronephrotic kidney:

<table>
<thead>
<tr>
<th>Left kidney</th>
<th>Right kidney</th>
</tr>
</thead>
<tbody>
<tr>
<td>(hydronephrotic)</td>
<td>(healthy)</td>
</tr>
<tr>
<td>Urea 0.45 per cent.</td>
<td>Urea 1.4 per cent.</td>
</tr>
<tr>
<td>Urea 0.55 per cent.</td>
<td>Urea 1.5 per cent.</td>
</tr>
<tr>
<td>Urea 0.68 per cent.</td>
<td>Urea 0.93 per cent.</td>
</tr>
<tr>
<td>Urea 0.45 per cent.</td>
<td>Urea 0.89 per cent.</td>
</tr>
<tr>
<td>Urea 0.49 per cent.</td>
<td>Urea 0.9 per cent.</td>
</tr>
<tr>
<td>Urea 0.5 per cent.</td>
<td>Urea 1.0 per cent.</td>
</tr>
<tr>
<td>Urea 0.6 per cent.</td>
<td>Urea 1.0 per cent.</td>
</tr>
<tr>
<td>Urea 0.55 per cent.</td>
<td>Urea 1.0 per cent.</td>
</tr>
</tbody>
</table>

Variations in the elimination of sodium chloride and phosphates follow those of urea. The methylene blue test shows a corresponding reduction in the functional power as the following observations show:

<table>
<thead>
<tr>
<th>Healthy kidney</th>
<th>Hydronephrotic kidney</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elimination of blue:</td>
<td>Commenced fifteen minutes.</td>
</tr>
<tr>
<td>Quantity satisfactory.</td>
<td>Quantity very small.</td>
</tr>
<tr>
<td>Duration 4 days.</td>
<td>Duration 3 days.</td>
</tr>
<tr>
<td>Elimination of chromogen:</td>
<td>Commenced fifteen minutes.</td>
</tr>
<tr>
<td>Quantity satisfactory.</td>
<td>Quantity greater than blue.</td>
</tr>
<tr>
<td>Duration two days.</td>
<td>Duration three days.</td>
</tr>
</tbody>
</table>

Significant figures are also obtained by the use of phloridzin. In a case of calculous hydronephrosis the injection of 5 mg. phloridzin gave the following result:

<table>
<thead>
<tr>
<th>Right healthy kidney</th>
<th>Left hydronephrotic kidney</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar, .510 gramme.</td>
<td>Trace.</td>
</tr>
</tbody>
</table>

In a case of bilateral hydronephrosis the intramuscular injection of 5 mg. of phenol-sulphone-phthalein was followed by staining of the urine in 29 minutes. The left kidney was completely blocked and no urine passed, the urine from the right kidney showed a percentage of the coloring material of 3.25 during the first hour and 2.25 during the second hour instead of 40 to 60 per cent. during the first hour and 20 to 25 per cent. in the second hour observed in the normal individual.

But although the function of these kidneys is greatly impaired they are not worthless. I shall later describe a case (Case VI) in which I operated for the relief of advanced...
hydronephrosis in both kidneys and the patient is well and doing a full day's work two years after the second operation and probably much longer after the development of the bilateral hydronephrosis. What remains of the renal tissue in his case has been saved but there is just sufficient to carry on the renal functions and at any time this may fail.

2. After the relief of obstruction, either temporary by natural means in an intermittent hydronephrosis or permanent by operative interference, the kidney does not return to its normal state.

The following case of bilateral hydronephrosis illustrates the gradual decline in the functional powers of the kidneys in spite of successful relief of the obstruction.

Case I.—Mrs. D., aged thirty, first noticed a swelling in the right side of the abdomen twelve months ago, two months after the birth of her only child. Pregnancy and the puerperium had been normal. There was dragging pain in the loin followed by appearance of the swelling and vomiting. The attack lasted about twelve hours, and then the swelling subsided and a large quantity of urine was discharged. There had been twelve such attacks. There was nocturnal frequency but no other urinary symptoms. On examination there was a large fairly tense movable hydronephrosis on the right side extending as low as the pubic symphysis. A vertical groove indicated the division between the distended renal pelvis and kidney. The left kidney was not palpable. The bladder was healthy, the right ureteric orifice small and surrounded by a blush of congestion. The orifice contracts at regular intervals and emits a copious clear efflux. Left ureter larger and normal in appearance and shows regular contraction and a clear efflux. A No. 7 F. ureteric catheter passed up the right ureter for sixteen inches without meeting obstruction and a constant stream of clear urine flowed from it under considerable pressure which could be increased by pressure upon the hydronephrosis. In half an hour 13 ounces of clear urine were withdrawn, the hydronephrosis was reduced to a flat, fairly movable mass and the urine issued from the catheter in slowly intermittent drops. An intramuscular injection of phenol-sulphone-phthalein was made after catheterization of
the second ureter. No urine escaped from the catheter in the left ureter during the whole of the test. The urine from the right kidney became colored in 29 minutes. During the first hour only 3.25 per cent. and during the second hour a similar percentage of the coloring material was obtained. On the following morning a hydronephrotic swelling was found on the left side of the abdomen. This was slightly smaller than that on the right side.

On July 16 the following operation was performed on the right kidney: (1) The kidney was exposed and dislocated from the wound. The ureter was found bound down to the surface of the greatly distended pelvis by fine adhesions and was dissected up to its insertion into the pelvis. A large flap of fibro-fatty tissue covering the posterior surface of the greatly distended pelvis was turned back. A triangular area, the size of the palm of the hand with the apex toward the ureteropelvic junction, comprising nearly the whole of the posterior wall of the pelvis was removed. The pelvic ureteral junction was narrow and the incision was carried down through this into the ureter and this part of the incision stitched transversely. The edges of the pelvic wound were brought together by a series of interrupted catgut sutures and the line of suture was covered by the flap of fibro-fatty tissue. The capsule was stripped from the posterior surface of the kidney and the organ fixed by catgut sutures to the posterior abdominal wall. Blood appeared in the urine for three days and then the urine became clear. Healing was aseptic.

The left kidney continued painful and distended. Three weeks after the operation the right kidney was not enlarged or tender but the left kidney was large, tense and painful. Cystoscopy showed a copious clear efflux from the right ureteric orifice. The left ureteric orifice was widely open and showed an occasional feeble contraction without efflux.

A ureteric catheter passed for 12 inches and was then arrested. It passed on after a little manipulation and urine flowed. On August 9 a plastic operation similar to that done on the right kidney was performed on the left kidney. The contents of the kidney were turbid and there were six small facetted black stones. A ureteral catheter was passed through an incision in the convex border of the kidney across the cavity of the pelvis and down the ureter for two inches. A rubber tube was placed
alongside this to drain the pelvic cavity and another in the peri-
renal tissues. The ureteric catheter was removed at the end of
a week and the tube a few days later and the wound healed.
The temperature rose a week after the operation and fell to
normal after a week. The patient began to lose flesh about the
time of the second operation and this gradually progressed until
she became emaciated. There was thirst and dry tongue,
anorexia and headache and the urine had a specific gravity of
1007. The quantity of urine varied from 30 to 48 ounces. A
month after the second operation the symptoms of renal failure
gradually increased. The temperature which had been normal
became subnormal and the quantity of urine diminished to 28
and then to 18 ounces. She died six weeks after the second
operation of renal failure.

There must be a time, I admit, in the early stage of hydron-
ephrosis when permanent relief of obstruction will be fol-
lowed by complete restoration of the kidney to its former
condition. But this time is at the very commencement of the
dilatation. It is long past when the kidney can be felt enlarged
on palpation of the abdomen.

The damage produced by obstruction in fully developed
hydronephrosis is permanent. I shall later show proof of
this in several cases (notably Case VI) examined after re-
moval of the obstruction.

From the foregoing it will, I think, be admitted that a
diagnosis must be made in the first stage of hydronephrosis, so
that operation may be undertaken before permanent damage
has been done to the kidney. I shall therefore discuss briefly
the diagnosis in this stage, that is, in the stage of commencing
dilatation of the kidney when the organ is not yet recognized
as being enlarged on palpation of the abdomen.

There are two well-defined clinical groups of cases. In
one group some recognized cause of hydronephrosis such as
calculus or movable kidney is discovered on clinical examina-
tion and in the second group no condition which might cause
hydronephrosis is found clinically. The obstruction in the
latter group is due to congenital stenosis or valves of the
EARLY DIAGNOSIS OF HYDRONEPHROSIS.

urteropelvic junction or to the pressure of aberrant renal vessels.

1. I shall take the simple stone cases first. The diagnosis of stone in the pelvis of the kidney or impacted in the ureter does not come within the province of this article. I wish to take a step further.

Let us suppose that the diagnosis of stone at the upper end of the ureter or of stone impacted in the ureter is made by symptoms and by the X-rays. The question will at once arise, "Is the presence of the stone causing damage to the kidney?" It might do so in two ways, either by being the predisposing cause of infection or by causing dilatation of the ureter, pelvis and kidney. This question has a very important bearing on our decision in regard to immediate operation.

Few surgeons will, I think, state that every calculus which is recently impacted in the ureter must at once be removed. In my experience over 50 per cent. of calculi found in the ureter are passed into the bladder and discharged with the urine. There are calculi which from their large size or oval, round, or elongated contour, as shown by the X-rays, we know cannot pass and must be removed by operation. To these I need not further refer. But there is a larger class of cases where a small oval calculus has recently become impacted in the ureter. By energetic diuretic treatment supplemented sometimes by a visit to a suitable watering-place, a large number of such calculi pass and no surgical operation is required. In others this treatment fails, obstruction commences gradually and the ureter and kidney become dilated. At what period must we say that diuretic treatment has failed and operation is imperative? Undoubtedly as I have already insisted, in the earliest stage of dilatation, before permanent damage has resulted.

What now are the signs of commencing dilatation of the kidney in a case of ureteric calculus? Pain has been present in the form of renal colic. There may have been a single attack and no more, but usually there are repeated attacks at irregular intervals depending upon exercise or the taking of diuretics, medicinal or dietetic, or upon other causes. As time
passes these attacks become less frequent and in the absence of pain the patient becomes more reconciled to the presence of the calculus in his ureter and less inclined to accept the suggestion of an operation. This prolongation of the intervals of colic with diminution in the severity of the attack and eventual reduction to an occasional ache is, I hold, significant of a dilating ureter and renal pelvis. I shall later show that the renal pelvis becomes less and less sensitive as it dilates until a period is reached when even comparatively powerful distention does not give rise to pain. And, moreover, the muscular tissue of the pelvis and ureter are progressively destroyed so that the muscular spasm which constitutes renal colic becomes less and less violent. The gradual disappearance of colic is therefore an important sign of dilatation, but when it has become apparent the dilatation is already well advanced and permanent damage has been done to the ureter and kidney.

Constant aching may be present in the kidney and is a sign of commencing dilatation. It is, however, often absent and when present may be due to other causes.

Persistent polyuria is a significant symptom when it exists, but it is readily overlooked and when noted may be regarded as a sign of chronic Bright's disease rather than of a dilating kidney on one side. The following case is so interesting in this connection that I venture to insert it here:

Case II.—W. R. W., a well built man of thirty-eight, was referred to me by Dr. A. J. Whiting, complaining of pain in the left flank and "deterioration of health." Two years previously he had pain in the left loin and albumin was discovered in the urine. The albumin diminished with rest and treatment. Nine months after the first attack of pain there was a second, and similar attacks have recurred at intervals of some months since that time. He suffered from headache, giddiness and nausea. The urine was acid, specific gravity 1006 and contained albumin which varied from a haze to 175 per mg. The quantity varied from 120 to 165 ounces in 24 hours. Casts, blood or pus have never been found in the urine. A small round calculus was shown by the X-rays in the left ureter just outside the
bladder. The ureteric orifice was surrounded by thickened, deep red, wrinkled mucous membrane.

In consultation, the late Sir William Allchin held that chronic interstitial nephritis was present in addition to the stone and was the cause of the polyuria although the absence of cardiovascular changes was remarkable. The stone was removed extraperitoneally and the ureter was found dilated to the size of the little finger. Convalescence was uninterrupted. The sequel was striking and I am indebted to Dr. A. R. Whiting for a most painstaking examination of the urine. The quantity of urine fell to an average of between 40 to 50 ounces in 24 hours with a specific gravity varying from 1010 to 1024 and urea from 6 to 7 grains per ounce. In two months the albumin had completely disappeared.

It will be seen that the symptoms of gradual dilatation of the kidney in ureteric calculus are few and variable and until dilatation has become fully established a diagnosis cannot be made. Similar difficulties exist in regard to the early diagnosis of hydronephrosis resulting from abnormal mobility of the kidney.

2. I shall now refer to the second class of cases where no obvious cause of obstruction is discovered clinically and at operation the block is found to be due to congenital stenosis or valve formation at the ureteropelvic junction, or to the pressure of an aberrant renal artery. The symptoms that may precede the appearance of a tumor in the loin in these cases are pain and intermittent polyuria. Two well-defined types of pain are observed. In one there is constant dull aching which may be worse on movement or on lifting weights. The following case illustrates this type:

Case III.—G. J., a warehouseman, aged forty-two, came under my observation at St. Peter's Hospital in July, 1906. He had suffered for eight years from dull aching pain in the right side of the abdomen extending round to the back. He had been examined at St. Peter's Hospital when the pain first began but nothing was found. The pain gradually subsided and he felt little of it for 4 or 5 years and then it appeared again and gradu-
ally increased for 3 years. The pain was worse after muscular exertion and better after rest. For six years he had been subject to attacks of vomiting and for over a year had been treated at a large general hospital for dyspepsia. The urine had not shown any abnormality in quantity or appearance.

In July, 1906, I found a large elastic renal tumor on the right side. An X-ray examination was negative. The right ureteric orifice was thick-lipped, elongated and motionless. A bougie opaque to the X-rays passed up the ureter to the transverse process of the third lumbar vertebra. No urine was obtained by ureteric catheter on the right side. On operating I found a large thin-walled hydronephrotic sac with stenosis at the ureteropelvic junction and performed nephrectomy.

The second type of pain in commencing hydronephrosis occurs in severe intermittent attacks of colic occurring without other symptoms.

The following is an example of such a case when obstruction was due to an aberrant renal artery and vein.

**Case IV.—** W. D., a boy aged thirteen, complained of attacks of pain in the left loin during the past eighteen months. The pain was severe and was usually accompanied by vomiting. It did not radiate. There was aching afterward but the boy was quite well in the interval. The attacks came on once a week on Saturday. Friday was a holiday and was spent in playing outdoor games. There had been no haematuria and no sudden variation in the quantity of urine. I examined him after the pain had been going on for about a year but could find nothing abnormal and the X-ray examination was negative to stone. Six months later I again examined him. The lower pole of both kidneys was palpable but no enlargement could be detected and there was no tenderness. On operation I found a lobulated, slightly enlarged kidney with a large distended pelvis. The ureter was normal in size and appearance. Crossing the ureteropelvic junction there was a band of fibrous tissue containing a large artery and vein passing to and from the anterior surface of the lower pole of the kidney. The point of obstruction of the ureter was situated at the crossing of the vessels. The vessels were ligatured and divided and the pelvis opened and
examined. No obstruction remained after cutting the vascular band. The lower pole of the kidney became blanched and remained pale for about a quarter of an hour when it gradually assumed a deep red color.

Constant aching pain in the renal region may arise from many conditions other than early hydronephrosis. I have seen it in osteo-arthritis of the vertebrae and this subject has been referred to in an excellent article by Dr. Chute of Boston. There are also bowel pains, duodenal or colon, and gall-bladder pains which lie so near to the kidney area as to make confusion possible. But apart from extrarenal causes of pain there are many conditions which may give rise to pain in the kidney even when the common surgical causes such as stone, tuberculosis and growths are excluded. Unilateral renal aching may occur in slight pyelitis, interstitial nephritis, phosphaturia, and oxaluria. It is not possible to submit every case of renal aching to operation, but short of this a diagnosis of commencing hydronephrosis cannot be made from pain alone.

Acute attacks of renal pain are more likely to lead to a diagnosis, but even here, attacks of vomiting or other collateral symptoms are likely to lead the surgeon astray when the lower pole of the kidney can be felt normal in size. Intermittent polyuria is an unreliable symptom. Time and again I have received a clear account of this symptom and found no dilatation of the kidney at operation. Two examples of this will be described later (Cases VIII and IX).

Intermittent hysterical polyuria is common and when this is combined with abdominal pain nothing appears to be wanting in the history of an intermittent hydronephrosis, especially when the kidney is unduly movable.

In the foregoing remarks I have endeavored to show that a diagnosis of dilatation of the kidney is seldom if ever made before a palpable tumor appears in the loin and that when the hydronephrosis has reached this stage there is extensive damage to the kidney which is permanent.

I shall pass now to the methods by which a diagnosis of dilatation of the kidney can be made in its earliest stage.
THE X-RAYS AND URETERAL CATHETER IN DIAGNOSIS OF HYDRONEPHROSIS.

(a) The outline of the kidney shown by the X-rays. When the dilated kidney is of large size there is little difficulty in recognizing its dimensions by means of the X-rays. In some cases the great extent of the shadow may tend to obscure the reading of the radiographic plate. The upper pole is under cover of the ribs while the lower is hidden by the shadow of the iliac crest. When calculi are present as they were in Case VI they frequently mark the lower limit of the hydronephrotic kidney and may also show the position of the obstruction at the pelvis of the kidney.

The great extent of the renal shadow will thus be more readily grasped and the reading of the plate become plainer. When the hydronephrosis is of medium size there will be less difficulty in recognizing a renal shadow for the lower limit lies within the clear loin area. There is more difficulty in detecting slight enlargements of the kidney shadow.

An experienced radiographer can show the outline of the kidney even in stout subjects. If a fixed position is used and the kidney is not displaced, the shadow will bear a constant relation to the vertebrae, ribs, and psoas muscle. There is, however, no standard size for the kidney, which will fit all patients. The normal kidney varies in size in men and women and also in different individuals so that slight variations in the extent of the shadow cannot be accepted without further proof, as indicating enlargement of the organ. Apart from that, the varying size of the body makes it impossible to give the kidney the same relation to the plate in each, and unless this can be ensured, uniformity of size of the shadow cannot be obtained. The relation of the kidney shadow to the twelfth rib gives no help, for this rib varies very greatly in length and in the angle it forms with the vertebrae, not only in different individuals but also on each side in the same individual.

(b) Proportional renal mensuration. With the object of obtaining some method of measurement which will be un-
measurement of the kidney shadow. A, A, A, opaque segments (1/2 inch) of catheter; B, points at margin of kidney shadow; C, measuring line, in half inches, across kidney shadow.

fig. 2.

c, dichotomous pelvis, not dilated; D, E, calyces; B, junction of ureter and pelvis. A, opaque catheter in ureter.
affected by the size of the individual and the distance of the kidney from this plate I have used the shadow thrown by the vertebral bodies in the individual under examination as a means of measuring the size of the kidney. The variation in the breadth of the vertebral bodies appears to run parallel with the variation in size of the normal kidney and, presuming that the kidney is not displaced, a fact that is easily ascertained, the method is a sufficiently accurate guide for routine examination. It is as follows:

If the narrowest transverse measurement of the shadow thrown by the first lumbar vertebra be taken and this measurement doubled and projected transversely from the outer edge of the vertebral body at its middle, a point will be found. If the same measurement be made in regard to the second and third lumbar vertebra two other points will be obtained. By joining these three points the outer border of the normal kidney is roughly indicated. Any increase beyond this line may be regarded as abnormal.

Further I have found it possible to measure the size of the kidney and to express the measurement in inches or fractions of an inch in the following manner. My ureteric catheters are made with an alternate opaque and translucent band each of which is half an inch. If one of these catheters be passed up the ureter to the kidney the opaque and translucent bands will show in the same plane as the kidney and the relative shadow value of half an inch is obtained. By marking a piece of paper in half inch values and laying it across the kidney shadow the actual size of the kidney is found (Fig. 1). Anatomically there is a slight difference between the X-ray shadow of the kidney and the actual breadth of the organ. The kidney does not lie absolutely flat, for the hilum is tilted slightly forward so that the shadow is narrowed to an insignificant extent.

An increase in size in the outline of the kidney indicates that dilatation has already taken place.

(c) Kelly's method of estimating the capacity of the renal pelvis. A ureteral catheter is passed so that the eye enters the
renal pelvis. The urine is allowed to run off and warm boracic solution or saline solution is slowly injected into the renal pelvis by means of a syringe. When the pelvis is full the tension causes pain in the kidney. The quantity which has been injected is now noted and is taken as the capacity of the renal pelvis. If the injection be stopped the pain passes off quickly as the fluid drops away from the ureteric catheter. If the fluid is too cold or if it is injected too quickly, spasm of the renal pelvis is set up and pain occurs before the pelvis is full. A capacity of 30 to 40 c.c. represents a slight degree of hydronephrosis. According to Braasch if 150 c.c. can be injected but little secreting tissue remains.

In practice there are certain difficulties and fallacies in this method. There are at present very divergent views as to the normal capacity of the renal pelvis. Luys states the normal capacity as 2 to 3 c.c. Braasch found the renal pelvis post mortem had a cubic content of 2 to 5 c.c. whereas in the living it will often hold 20 c.c. or more, while Bazy looks upon a pelvis which contains 30 to 35 c.c. as normal. In my own cases checked by pyelography or operation the normal pelvis did not exceed 5 or 7 c.c. in capacity and was usually less. Until we can obtain more extensive observations on the capacity of the healthy pelvis, the earlier stages of dilatation are likely to be overlooked by this method.

Another fallacy is the escape of some fluid along the ureter outside the catheter. By placing a catheter in the urethra and coloring the injection fluid with methylene blue any escape will be detected by the urine draining from the bladder being tinged with blue, but the amount cannot be measured, as it will be blended with the urine from the other kidney.

Still another fallacy appears to me to arise in making these observations. A kidney working under raised pressure, as these slightly hydronephrotic kidneys are, usually shows polyuria. With a fine-bore catheter, such as we use for the ureter, it is difficult to empty the pelvis completely when an abundant polyuria is in progress, and it is certain that while the boric lotion is being slowly injected the kidney is rapidly
secretion of urine. The distention of the pelvis is thus due, not only to the artificial injection but also to the urine. I believe therefore that the capacity of the pelvis is frequently underestimated by this method.

(d) Pyelography. By this method, introduced by Voelcker and Lichtenberg, a diagnosis of dilatation of the kidney pelvis and calyces can be made before the outline of the organ is increased in size.

Pyelography consists in filling the pelvis of the kidney with an innocuous fluid opaque to the X-rays and obtaining a radiogram. The method of pyelography has been fully described elsewhere and only the salient points need be repeated. A catheter is passed up the ureter so that the eye enters the renal pelvis and the contents are allowed to run off. The bladder is emptied and the cystoscope removed leaving the ureteric catheter in position. The collargol solution is heated and slowly introduced. I use either a solution of 10 per cent. or 20 per cent. and introduce it by means of an all-glass syringe of 20 c.c. capacity. A blunt hollow needle is used and fits into the catheter and a fine plug should be provided to fit the catheter after the injection is complete. The fluid is introduced by hydrostatic pressure aided by an occasional touch of the finger and of the piston. The barrel of the syringe filled with solution and with the piston in place is attached to the catheter by means of the needle and held as high as the free end of the ureteral catheter will allow. This is about a foot above the level of the body. The quantity introduced varies with the capacity of the pelvis; 40 c.c. or more may be required in a dilated kidney. The patient gives the signal to stop when he feels pain in the pelvis of the kidney. The syringe is then removed and the end of the ureteral catheter plugged and the radiographer proceeds without delay with his photography. The value of the radiogram is much enhanced by the use of an opaque catheter which shows the line of the ureter and the angle of the ureteropelvic junction. When the radiogram has been taken the plug is removed from
the catheter and the fluid allowed to syphon off. The catheter is removed at the end of ten minutes.

In normal individuals the amount of pain varies. Some have pain only at the time of full distention of the pelvis, others have a dull aching for several hours. In one case, that of a very nervous woman, there was a complete absence of pain at the time of full distention of the pelvis, but a feeling of rawness in the pelvis and ureter the next day. There was no dilatation of the pelvis in this case. In another case of commencing dilatation when the pelvis held 18 c.c. of collargol solution there was no discomfort until two hours later and this quickly passed off.

In some cases a severe attack of renal colic follows the examination. It is very important to avoid this during the radiographic exposure as, apart from the inconvenience to the patient, the tense rigid muscles obstruct the passage of the X-rays and this, together with the movement of the patient and the arching of the back which interfere with the action of a compressor, all militate against the production of a sharply defined shadow. The colic may be due to several factors: too rapid filling of the pelvis, too great pressure in injecting the fluid and thus causing over-distention of the pelvis, too cold or too hot solution of collargol are all contributory causes. These points should therefore receive the most careful and detailed attention and the introduction of the fluid should at once be stopped when the sensation of tension in the renal pelvis commences. I have abandoned the practice of giving a hypodermic injection of morphia before the operation as I believe the sensations of the patient are an important guide in the operation. What can we learn by this method?

1. Is dilatation present? It is possible during the introduction of the collargol to say with tolerable certainty whether dilatation is absent or whether advanced dilatation is present. When the pelvis is not dilated the flow of collargol is slow, the patient soon feels pain in the kidney and the quantity that enters is small. The greater the extent to which dilatation has developed, the less sensitive does the pelvis become. I have
Fig. 3.

Normal funnel-shaped pelvis with calyces. Point of opaque catheter in upper calyx.

Fig. 4.

Kinking of the ureteropelvic junction and commencing hydrenephrosis in lateral scoliosis.
already referred to this insensitiveness of the dilated renal pelvis as an important point in clinical diagnosis apart from pyelography. Pain appears late and is moderate and may amount merely to a dull ache. The fluid enters rapidly and in quantity.

The outflow of collargol after the examination also varies. The non-dilated pelvis with its healthy muscular wall rapidly gets rid of the collargol and the urine is clear in 24 hours or even in 12 hours. In one case the urine was stained only the first micturition after the examination. In the dilated kidney the urine remains stained for several days or a week or even longer.

On examining a number of plates it will be seen that there are two chief types of normal pelvis. In one, the dichotomous pelvis (Fig. 2), the upper end of the ureter splits into two branches without any dilatation and from these branches the calyces arise. In the second form of pelvis the ureter expands into a funnel-shaped pelvis (Fig. 3) from which primary branches project and on these are set the calyces.

When dilatation commences the calyces become clubbed and then elongated so that in a kidney, the seat of moderate distention, the calyces are seen as long processes with rounded ends penetrating deeply into the shadow thrown by the renal substance, and eventually reaching the surface of the kidney. They are well seen in Fig. 6 where the outline of the kidney is clearly defined and the opaque clubbed calyces extend to the limits of the renal shadow. At this stage the true pelvis of the kidney is not necessarily much dilated. In Fig. 6 it does not appear to be dilated at all. This is the "renal" type of hydronephrosis, the final stage of which is seen in Fig. 8. In this case of advanced hydronephrosis the fibrous septa remaining between the pockets of the hydronephrosis, which were originally the calyces, could be detected as clear lines cutting into the opaque block of the collargol filled kidney (Fig. 8).

In the "pelvic" type of hydronephrosis the funnel-shaped pelvis becomes more and more globular. As dilatation proceeds the calyces become broader and shorter and approach
each other and they gradually become drawn into the renal pelvis until they have completely disappeared. In this type of hydronephrosis the collargol shadow shows a large uniformly opaque globular shadow on the surface of which small bosses may project (Fig. 11).

An important factor in the production of certain forms of hydronephrosis is some variation in the angle of union of the renal pelvis and ureter. I find that information in regard to the contour of this junction can be obtained by pyelography. In the normal individual the ureter passes up alongside the bodies of the lumbar vertebrae crossing the transverse processes of the fifth and fourth lumbar vertebrae and the tip of the transverse process of the third lumbar vertebra. Its axis is then continued directly into that of the pelvis of the kidney. This can be demonstrated by pyelography with an opaque catheter in the ureter. The line which this catheter takes in the normal individual is either quite straight or has a gentle curve outward commencing at the level of the third lumbar vertebra. A kink of this ureteropelvic junction is shown by pyelography in Fig. 10, a case of movable kidney which has been anchored in a faulty position. In another case of lateral curvature of the lumbar vertebra a very marked distortion of the ureteropelvic junction with irregular dilatation of the calyces is seen (Fig. 4). Further information may also be obtained.

An opaque flexible catheter or bougie passed up the ureter into the kidney pelvis enters the upper calyx of the kidney in the normally placed non-dilated organ. This is seen in Fig. 3 where the renal pelvis and calyces are filled with collargol and throw a sharp shadow. The catheter shadow is denser than that of the collargol and the point is seen lying in the upper calyx. When, however, the kidney is displaced downward or the pelvis dilated the catheter does not enter the calyx but impinges on the upper wall of the pelvis pushing it up like the pole of a tent (Fig. 11).

Another point of extreme interest which is seen in examining plates showing the collargol filled pelvis and calyces with
an opaque catheter in the ureter is the variation in the angle formed by the ureter and outer and lower margin of the pelvis with the inner margin of the shadow by the lowest calyx.

This pelvocalycine angle is a widely open angle with a rounded apex in the normal state (see Figs. 3 and 9). When the calyces of the kidney begin to dilate in early hydronephrosis this angle is reduced in size and as dilatation proceeds the shadow thrown by the lower calyx approaches that of the ureter until the angle becomes acute and the space between the shadows is reduced to a narrow vertical slit (Fig. 6). A similar change takes place when the hydronephrosis is of the "pelvic" type. Here the angle between the lower margin of the distended pelvis and the ureter becomes acute (Fig. 11).

It is possible that a similar change takes place in cases of movable kidney when the movement is of the "cinder sifting" type but I have not had an opportunity of demonstrating this.

2. What is the position of the obstruction? The presence of a stone in the renal pelvis or ureter will indicate the position of the obstruction. When no stone is present the collargol shadow may render assistance.

When the obstruction is at the ureteropelvic junction the shadow stops short abruptly at the pelvic outlet but when the obstruction is low down in the ureter it tails off as it passes down the ureter. Where the ureter is dilated a shadow of the collargol filled tube may be obtained, as Braasch has shown. In a case where the obstruction was due to a movable kidney I was able after nephropexy to show the dilated pelvis and the collargol passing down the ureter in waves, demonstrating the absence of obstruction and the contractile power of the ureter (Fig. 11). The presence of an opaque segment of the catheter (1 centimetre long) in the clear area of ureteral contraction showed the length of this wave of ureteral contraction to be about 2 centimetres.

3. Is an abdominal tumor a hydronephrosis or is it unconnected with the kidney? An abdominal tumor may in its
position, shape, and movements closely resemble an enlarged kidney, the history may give no clue to its origin and there are no changes in the urine and no symptoms pointing to disease of other organs to indicate the nature of the tumor. In such a case the collargol method gives invaluable information.

In Case XIII there was an abdominal tumor which had the shape and position of a kidney and which had been diagnosed as a hydronephrosis by a surgeon of large experience. Pyelography showed that the renal pelvis and calyces were normal in size and outline and were situated some distance above the swelling. Operation demonstrated a mass of hydatid cysts attached to the under surface of the liver.

Two other cases operated on in succession on the same day may be quoted in illustration of the use of this method. Both patients were women. In the first there had been attacks of pain in the right side of the abdomen, an indefinite history of an attack of hematuria and a doubtful history of jaundice lasting two or three days. There was a large rounded swelling in the right lumbar region which in many respects resembled an enlarged kidney. Collargol injection showed the pelvis and calyces of the right kidney normal and situated high up beneath the ribs. Operation showed the right lobe of the liver dragged down and with its edge concealed by adherent bowel and a gall-bladder full of gall-stones.

In the second case there was a swelling in the left loin with a history of "cystitis." Pyelography demonstrated a normal pelvis and calyces situated above the mass. Operation showed a hard fibrolipomatous mass adherent to the lower end of the kidney and to the colon in the midst of which were caseous masses. The details of the cases are given on a later page.

Let us now give some illustrations of the value of this method.

1. *Calculus impacted in the ureter. Is dilatation of the kidney commencing?* (Figs. 5 and 6.)
Calculus impacted in right ureter. Opaque bougie arrested by calculus.

Early hydronephrosis due to stone in ureter. Note marked clubbing and elongation of calyces. Pelvis normal.
**Fig. 7.**

A, calculus in pelvic segment of ureter; B C, opaque bougie passed up ureter alongside it.

**Fig. 8**

A, hydronephrosis, left kidney, renal type. Note fine partitions (clear lines) between pockets. Large hydronephrosis, right kidney. B, upper limit of kidney; C, stone at lower pole of kidney; D, stone at renal pelvis; E, edge of psoas muscle.
CASE V.—F. M., an engineer's fitter, aged forty-three, suffered from slight pain in the right loin and across the base of the sacrum and from difficult micturition for six or seven years. The difficulty in micturition was intermittent. It was worse when the pain was present and better when it was relieved. The pain came on in attacks with intervals varying from 14 days to 12 months. It radiated along the line of the right ureter into the right testicle and down the right thigh and might last for a week at a time. Occasionally there was pain in the left loin. There was no hematuria but the urine contained pus. He passed water every three or four hours during the day and occasionally once at night. The kidneys were not palpable or tender.

The X-rays showed an oval calculus of moderate size on the right ureter at the level of the brim of the pelvis. An opaque bougie was passed up the right ureter. There was a hitch at the level of the pelvic brim and the catheter passed on into the renal pelvis. Collargol was introduced and practically no sensation was felt in the kidney by the patient.

In the skiagram the ureter is seen to pass outward from the level of the fifth lumbar vertebrae to join the neck of the pelvis which lies vertically just outside the tips of the transverse processes of the second and third lumbar vertebrae.

The pelvis is vertically placed and is of the funnel-shaped variety becoming gradually larger as it passes upward. The pelvis does not appear to be dilated and is not in any way distorted. It gives off four large branches, the upper of which passes upward and outward, the next two directly outward and the lowest directly downward.

These branches are long and gradually expand into a rounded or clubbed extremity which reaches to the surface of the shadow of the kidney. They are separated by broad wedges of renal substance. The lowest expanded branch which passes vertically downward lies close to the neck of the pelvis and is only separated from it by a narrow space so that the two shadows meet in an acute angle. The kidney shadow is slightly increased in breadth.

In a radiogram of the pelvis a broad band of collargol shadow is seen lying transversely across the pelvis and represents a
quantity of collargol which escaped from the kidney alongside the ureteric catheter.

I removed the ureteric calculus by the extraperitoneal route and the patient made an uninterrupted recovery.

2. After removal of a calculus which has obstructed the ureter and caused dilatation of the kidney, does the kidney return to its normal state?

CASE VI.—A. W., aged thirty-three, came under my observation at the Hampstead General Hospital in July, 1910, complaining of pain in the left side of the abdomen. He had suffered from pain in the left loin after exercise since he was four years old. At the age of 20 he lost this pain, but had pain along the urethra and at the age of 26 the loin pain returned and has continued since. He had been treated for dyspepsia before he came under my care. Neither kidney was palpable. A radiogram showed a large calculus in the pelvic segment of the left ureter (Fig. 7). This was removed in July, 1910, and the ureter was found dilated. No obstruction to the passage of bougies along the ureter remained after removal of the stone.

In November, 1910, he suffered from continuous haematuria for some weeks from the right kidney, but this kidney could not be felt on palpation of the abdomen. In February, 1911, I examined the kidneys with a view to operation on the right. I wished particularly to ascertain if the dilatation which I knew must have existed in the left kidney still remained.

The left ureter was catheterized and 40 c.c. of collargol solution (10 per cent.) introduced. There was no pain. A radiogram showed a dense collargol shadow on the left side which had the outline and appearance of a dilated kidney (Fig. 8). The rounded pockets of the hydronephrotic kidney were represented as dark rounded collargol shadows and these were separated by fine clear lines representing the fibrous septa.

On the right side the upper part of the kidney shadow lay behind the eleventh rib while a stone shadow in the lower part of the kidney lay below the crest of the ileum and another, evidently the plugging calculus, lay at the edge of the psoas at the level of the third lumbar vertebra. There was evidence here of a very large hydronephrosis on the right side and a smaller hydronephrosis on the left, yet neither could be felt on palpation of the abdomen.
On July 15, 1911, I exposed the right kidney and found a thin hydronephrotic sac of large dimensions adherent to the diaphragm above and extending into the iliac fossa. The ureter was normal in size. The calculi were removed and the obstruction was found to lie at the junction of ureter and pelvis but so buried in fat and fibrous tissue as to be inaccessible. I therefore brought the ureter up to the lower end of the kidney and formed a short circuit between the cavity at the lower pole of the kidney and the lumen of the ureter by lateral anastomosis. The patient is well and at work at the present time (April, 1913).

3. A stone has been passed from the kidney some years previously and there is recurrent pain but no calculous shadow. Is there stenosis of the pelvic outlet and commencing dilatation of the kidney? (Fig. 2.)

Case VII.—The patient, aged twenty years, had had a stone crushed by the late Mr. Reginal Harrison at the age of six years after suffering from left renal colic. For the last five years he had had pain at the end of the penis on passing urine and this had increased during the last month. The frequency of micturition was increased to two hours during the day and there was some urgency. On exertion he had pain in the left side which he localized to the region of the left kidney. The left kidney could not be felt and was not tender.

The radiographer's report was that there was no opacity from calculus, but that there was some increase in the opacity of the left flank, whether due to the enlargement of the left kidney or not, was doubtful. On cystoscopy there was basal cystitis and a patch of cystitis on the right wall of the bladder. The right ureter was open with thick edges, but contracted wall, and the efflux was clear; the left ureter was large, open, oval and did not contract. The efflux was not seen. It was probable in this case that there was some dilatation of the left kidney due to the passage of a calculus some years previously and that the dilatation might be due to progressive contraction at the ureteropelvic junction.

An opaque catheter was passed up the left ureter and warm collargol slowly introduced. Pain was felt at 7 c.c. and a radiogram was taken. The plate shows the shadow of a dichotomous pelvis with calyces. The highest and lowest calyces are clubbed
so that some dilatation is present, but it is insignificant. The ureter passes in a straight line into the pelvis so that there is no angling. The angle between the lowest calyx and the pelvis is wide.

From this examination I concluded that there was no important degree of dilatation and therefore no stenosis.

4. A movable kidney is present and hydronephrosis is diagnosed. Is dilatation present, and if so, what is its extent? (Fig. 9.)

In the following case hydronephrosis had been diagnosed by a competent surgeon and the diagnosis confirmed by a second surgeon. It was proved by pyelography that no dilatation of the renal pelvis or calyces was present.

Case VIII.—A. E., a servant maid aged twenty-nine, had an attack of pain in the right side of the abdomen in June, 1911, and was confined to bed for a week. In August she complained from time to time of dull aching pain in the right loin. In December, 1911, she had a severe attack of pain in the right iliac fossa radiating to the thigh and back, and accompanied by increased frequency of micturition, urgency and some pain and there was nausea and constipation. She was examined by a surgeon who did not feel the kidney on the first occasion but some days later a tender elastic swelling was felt in the right side of the abdomen which he regarded as a distended kidney. The patient stated that she felt a lump in the right side which disappeared at intervals and after relief from the pain she passed a large quantity of urine. Examination by a second surgeon gave on one occasion a negative result and on another a swelling was found. The case was referred to me as one of intermittent hydronephrosis in a movable kidney.

I was unable to feel the kidney on either side on the occasion on which I examined her and there was no tenderness. The bladder had a normal capacity and showed slight cystitis at the base, especially on the right side. A No. 7 silver wire bougie passed easily up the right ureter to the renal pelvis and collargol was introduced. The collargol solution flowed very slowly and required some pressure on the piston of the syringe. Pain appeared in the right kidney region soon after the injection of collargol was commenced, and rapidly became acute.
EARLY DIAGNOSIS OF HYDRONEPHROSIS.

A radiogram (Fig. 9) taken by Dr. Ironside Bruce showed the following:

The ureter lay in normal position across the transverse processes of the bodies of the fifth to the second lumbar vertebrae. The line of the upper end of the ureter is continued straight into that of the neck of the pelvis.

The pelvis lay opposite the intervertebral disc between the first and second lumbar vertebrae. It was of the single funnel-like type and split into four calyces. The upper calyx continued in a gentle curve the line of the upper end of the ureter and the neck of the pelvis.

The angle between the lowest calyx and the neck of the pelvis was wide and formed a full curve. There was no dilatation of the pelvis, no clubbing of the calyces. The outline of the kidney was normal. By this examination it was proved that no dilatation of the renal pelvis or calyces was present. At the urgent request of the patient I operated to fix the movable kidney.

The fascia of Zuckerkandl was thick and the perirenal fat absent except at the hilum. Tough fibrous bands passed from the fibrous capsule to the perirenal fascia. The pedicle was long and the kidney readily delivered through the wound. The pelvis was small and there was no hollowing of the kidney. Nephropexy was performed.

5. Nephropexy has been performed some years previously and there is aching pain in the loin. Is there dilatation of the kidney? (Fig. 3.)

Case IX.—B. F., a spare woman of thirty-six years, had suffered from movable left kidney for which nephropexy had been performed ten years previously.

For the last five years there has been dull aching in the left loin and all over the left side. This occasionally became acute but never radiated to the groin or labia. She occasionally vomited during an attack of pain. The urine was always clear. Urine was passed every two hours during the day and every half hour during the night for several months. There was some difficulty in passing water when the pain was acute and when the pain ceased a large quantity of water was passed. The pain was worse after exercise. The right kidney was not palpable or tender. The left loin was a little tender, but the kidney was not palpable. On cystoscopy, the bladder and ureteric
orifices were normal. There was no obstruction to the passage of a catheter up the left ureter. Collargol was injected and almost immediately pain was felt in the left kidney. A radiogram (Fig. 3) shows the ureter and pelvis in a continuous curved line passing upward and outward from the level of the transverse process of the fourth lumbar vertebrae. There is no kinking of the ureteropelvic junction. The pelvis is of the funnel-shaped type and is situated at the level of the upper part of the third lumbar vertebra and is lower and further from the vertebral column than normal. The point of the catheter is seen lying in the upper calyx having passed into it in a direct line from the ureter and neck of the pelvis. Passing outward from the pelvis are two branches, one of which passes transversely and another vertically downward from the lower angle. The angle between the lowest branch and the neck of the pelvis is wide. It will be seen from these details that no trace of dilatation of the calyces or of the pelvis exists.

6. *Nephropexy has been performed at a previous date, there is renal pain on movement and the kidney can be felt to swing laterally. Is there kinking of the ureteropelvic junction? (Fig. 10.)*

**Case X.**—A woman, aged forty-eight years, came under my observation at the Hampstead General Hospital. She complained of pain in the right side. The pain varied in severity and was relieved by lying down. There was increased frequency of micturition to every hour during the day and three or four times during the night. Nephropexy has been performed at another hospital eight years previously. On palpation the right kidney was readily felt in the right loin and the lower pole reached below the level of the umbilicus. I noted “the kidney appeared large, especially the upper part, which was more bulky than the lower part.”

The kidney moved with respiration but had a comparatively limited excursion and the lower pole appeared to swing toward the middle line so that it lay transversely. The bladder and ureters were healthy. The capacity of the right renal pelvis was 27 c.c. Collargol solution (10 per cent.) was introduced and a radiogram taken. The radiogram (Fig. 10) shows the ureter passing up in front of the transverse processes of the lumbar vertebrae and opposite the body of the third lumbar vertebra, it
Case of supposed hydronephrosis, collargol shadow showing normal pelvis with calyces. Opaque catheter in ureter.

Movable kidney. A, B, opaque catheter in ureter; C, kink at ureteropelvic junction; D, dilated calyx.
Hydronephrosis, pelvic type. Note dilated pelvis and on right of this dilated kidney: catheter raising up roof of pelvis; waves of collargol passing down ureter.

Hydronephrosis of pelvic type, due to pressure of aberrant renal vessels.
takes a sharp curve outward as it expands into the pelvis of the kidney. The upper calyx of the pelvis is very distinctly dilated.

I explored the kidney on March 15, 1911, and found an elongated kidney which was fixed by a band of fibrous tissue of the size of a shilling, to the tissues in the inner surface of the twelfth rib. This band allowed some amount of vertical movement, but the chief movement consisted in the lower pole of the kidney swinging toward the middle line. There was hollowing of the kidney which was most pronounced at the upper part. There was no narrowing of the ureter or ureteropelvic junction.

I looked upon the swinging movement as the cause of the angling of the ureteropelvic junction and dilatation of the upper calyx. The kidney was freed, the capsule stripped from its anterior and posterior surfaces, and the organ slung vertically by three catgut stitches, placed at intervals of an inch, both ends of the highest being passed through the intercostal muscles between the eleventh and twelfth ribs and tied.

In this case pyelography showed that the upper calyces were dilated, and confirmed the view that this was due to the abnormal position and the movement of the kidney.

7. Examination of a dilated movable kidney after nephropexy showing an openly actively contracting ureter (Fig. 11).

Case XI.—E. A., a servant maid aged twenty years, had suffered from pain in the back and right side for two years. She experienced the sensation of a lump in the side and there was an occasional attack of lumbar pain more severe on lying on her back. There was no history of Dietl's crises or of variations in the quantity of urine. The right kidney was freely movable and could be displaced into the right iliac fossa. It was not enlarged or tender.

Nephropexy was performed in February, 1912. The fascia of Zuckerkandl was thick and the perirenal fat entirely wanting. Tough fibrous bands passed between the thickened fibrous capsule and the fascia. The kidney lay in the iliac fossa with its upper pole below the level of the iliac crest. The kidney pelvis was large and flabby and the kidney sinus admitted three fingers. Nephropexy was performed by partial decapsulation and catgut suture. The kidney was examined by pyelography three weeks after the operation. Collargol entered the pelvis easily and there was no pain. The pyelogram (Fig. 11) shows a greatly distended
renal pelvis and the outline of a dilated kidney. The pelvis is roughly quadrilateral in shape the upper and inner angle being formed by the catheter passing up this part of the pelvis. The renal portion of the shadow is a long oval shape with an undulating outline from the shallow pockets in the kidney being filled with collargol solution. From the lower and inner corner of the renal pelvis the ureter is seen to pass downward as a dark line varying in thickness as far as the level of the middle of the sacro-iliac synchondrosis. There are two narrow and two broad segments. The first narrow segment is at the ureteropelvic junction at the level of the intervertebral disc between the third and fourth lumbar vertebrae, then there is a short thickened segment extending to the lower border of the transverse process of the fifth lumbar vertebra and from this to the lower limit of the plate the opaque line is much thicker. In the narrow segments only the opaque catheter is seen, while in the thick segments are collections of collargol.

The phenomenon of ureteral contractions is here graphically demonstrated. The lower segment between the two broad bands is the full length of a wave of ureteral contractions passing down the ureter. In the narrow portion an opaque segment of catheter, 1 centimetre in length, is lying and by using this it is found that the length of the contraction wave is two centimetres.

8. Attacks of colic for three years, previous examination negative, recently left kidney felt enlarged. Collargol shows dilated pelvis. Aberrant renal artery on operation (Fig. 12).

Case XII.—F. H., a dental mechanic aged twenty-one, had complained of attacks of pain in the left loin during the last three years. Two years ago he was admitted to St. Peter's Hospital on account of renal colic, but the examination by X-rays was negative and the kidney was not palpable. Since that time he has had attacks of renal colic on an average of once a fortnight. The pain commences as a dull ache in the left posterior renal region and steadily increases reaching the maximum in two hours and then it radiates down the left side of the abdomen almost to the groin. Sickness and vomiting accompany the attacks. There has never been a haematuria and there has been no sudden increase in the quantity of urine after the attacks. The kidney has on one occasion been found enlarged and tender. There was no stone shadow with the X-rays.
When I examined him both kidneys were palpable, but neither was tender or enlarged. On cystoscopy the left ureteric orifice was larger. The efflux from both was clear. A catheter passed up the left ureter without meeting any obstruction. After injecting 28 c.c. collargol there was some pain. A radiogram (Fig. 12) shows a large oval collargol shadow opposite the bodies of the second and third lumbar vertebrae. The long axis of the oval runs parallel to the edge of the psoas muscle and a rounded projection overlaps the edge of this muscle at the level of the intervertebral disc between the second and third lumbar vertebrae. No calyces are visible. The shadow extends outward almost to the twelfth rib. The ureter contained no collargol. A diagnosis of hydronephrosis due to obstruction at the ureteropelvic junction was made.

On exposing the kidney I found a large lobulated kidney and a greatly distended renal pelvis. A band containing a large artery and vein passed across the ureter immediately below the distended pelvis and entered the hilum at its lower part. Below this band the ureter was normal in size. Above the band a little more than an inch of ureter was dilated and bound down to the surface of the dilated pelvis. The pressure of the band upon the ureter was clearly made out. On raising the vascular band on an aneurism needle, the ureter still remained adherent to the surface of the pelvis and the contents of the pelvis could not be made to pass into the ureter. The pelvis was opened on its anterior surface and the interior inspected. The opening of the ureter into the pelvis readily admitted a probe and there was no valve or stenosis here.

The probe passed down for about three-quarters of an inch and was then arrested. The aberrant vessels were now tied and cut across, but the probe did not pass. The ureter was dissected off the surface of the pelvis and at once the probe passed on, so that the actual obstruction was due to the adhesions. No blanching of the kidney followed ligature of the abnormal vessels. The wound in the pelvis was closed with catgut and the kidney fixed to the posterior abdominal wall with catgut sutures. Convalescence was uninterrupted.

9. A diagnosis of hydronephrosis has been made. Pyelography shows the renal pelvis normal in outline and position.
Operation reveals hydatid cysts projecting from under surface of liver (Fig. 13).

Case XIII.—L. C., a nursemaid aged twenty-seven, complained of attacks of acute pain in the right loin. Three and a half years ago she had an operation for appendicitis.

Four months ago she had a series of attacks of violent pain in the right side of abdomen situated over the right kidney and radiating transversely round the abdomen to the middle line but not downward. The pain commenced suddenly and was very severe, necessitating the administration of morphia. Vomiting usually accompanied an attack. There were about 12 attacks in the first week each lasting from 30 to 40 minutes. For three and a half months there has been no recurrence of the pain. An abdominal swelling was noticed when the pain commenced. She was examined after an attack of pain by a surgeon of recognized experience in urinary surgery who diagnosed an enlarged tender kidney and pronounced it a hydronephrosis or a tuberculous kidney. Since that time the swelling had remained unchanged.

When I examined her (November, 1912) there was a reniform swelling in the right side of the abdomen with the long axis placed obliquely from above down and inward. The mass was rounded and prominent and there was a rounded upper pole two finger-breadths below the costal margin. On the rounded outer border there was a nodule the size of a walnut. The inner border was depressed like the hilum of the kidney. The surface of the mass was smooth and the consistence uniformly hard. The mass moved in a vertical direction with respiration and was freely movable on palpation, passing downward to an inch below the level of the umbilicus and inward for two inches across the middle line.

The urine contained no abnormal elements. Cystoscopy showed a healthy bladder and normal ureteric orifices. Pyelography (Fig. 13) showed the renal pelvis and calyces normal in size and contour and situated at the level of the twelfth dorsal and first lumbar vertebrae, high above the position of the swelling. On December 6, 1912, I exposed the right kidney and found it normal. The abdominal cavity was then opened and a long, firm, yellow, kidney-shaped mass found adherent to the under surface of the lower border of the liver. After removal of adhesions to the bowel this was found to be a hydatid cyst and was removed.
Normal pelvis and calyces in case of abdominal hydatid cyst, resembling hydrenephrosis.

Normal renal pelvis and calyces in abdominal tumor, due to liver and enlarged gall-bladder.
Fig. 15.

Fully distended normal renal pelvis and calyces, outline of kidney normal, sarcomatous mass seen below the kidney.
The liver contained numerous large cavities filled with cysts and these were drained. Recovery was uninterrupted.

10. An abdominal tumor is present in the right loin. Pyelography shows the renal pelvis and calyces normal and situated high up above the tumor. At operation the swelling is found to be the right lobe of the liver and gall-bladder full of gall-stones.

Case XIV.—A. S., aged forty-two years, had suffered from attacks of pain in the right side of the abdomen and right iliac fossa for a year. The pain was very severe lasting for a few hours to a day and was accompanied by sickness and constipation. There was said to have been hematuria with the first attack, the blood being present in the urine for a week. At the commencement of the first attack the patient was said to have been jaundiced for two or three days, but this has not been noticed since.

There was a swelling on the right side of the abdomen extending from the costal margin to the iliac crest and inward to the middle line. The swelling was rounded on the surface and there was no sharp edge. It did not pass back into the costomuscular angle. The urine showed evidences of chronic interstitial nephritis and there was a high blood-pressure and changes in the heart and arteries. Pyelography was performed without difficulty there being a remarkable absence of pain when the renal pelvis was full of fluid. The renal pelvis and calyces were normal (Fig. 14) and the kidney was situated high up under the ribs well above the prominent part of the tumor. The abdomen was opened. The right lobe of the liver was dragged downward and inward and its margin concealed by masses of adhesions. The gall-bladder was packed with gall-stones and extensively adherent. The gall-stones were removed from the gall-bladder and cystic duct and the adhesions freed. Recovery was interrupted by an attack of hematuria resulting from an exacerbation of the chronic nephritis.

11. A tumor in the left loin is suspected to be renal. Pyelography demonstrates the pelvis and calyces normal and situated above the mass which is found on operation to be a mixed celled sarcoma of the perirenal tissue (Fig. 15).

Case XV.—M. T., aged fifty-nine years, gave a history of "inflammation of the bladder" three months previously followed by dull aching pain and tenderness in the left loin. She then felt a "lump" in the left side which was heavy and tender.
Examination of the abdomen showed a tumor in the left loin at the level of the iliac crest. This had a rounded lower border and passed upward beneath the ribs. It gave the impression of a partly distended hydronephrosis.

The renal pelvis held 18 c.c. and the collargol solution (20 per cent.) flowed easily. There was no trace of discomfort and the introduction was stopped as the flow had ceased. Radiography showed the renal pelvis tensely distended with collargol solution (Fig. 15). There are three primary divisions and each splits into two branches. There is no dilatation of the calyces. The renal outline is normal. At the lower end of the renal shadow there is a dark opaque mass. No pain followed the examination and the kidney was palpated next day without a trace of tenderness. An oblique incision was made and the lower pole of the kidney was found to be embedded in a hard apparently fibrolipomatous mass which extended downward into the left iliac fossa and inward beneath the descending colon. The colon was firmly adherent to the mass and was dissected off with considerable difficulty. It was impossible to separate the mass from the lower pole of the kidney which was invaded by it and nephrectomy was performed. On section of the kidney the pelvis was found to be normal and the mucous membrane healthy and glistening. The lower pole of the kidney showed streaks of fibrous tissue passing in from the surface with a few small yellowish patches and a greatly thickened capsule. Microscopical examination showed the mass to be a mixed celled sarcoma with large areas of degeneration and infiltration with inflammatory round-cells. The growth originated outside the kidney capsule.

DIFFICULTIES, FALLACIES AND DANGERS OF PYELOGRAPHY.

The method so far as can be judged by published work has been successful in the hands of a few observers, while others have had to confess to failures in a number of cases. It would be surprising if, at first, some failures did not occur in a method which is dependent upon a high degree of manipulative skill on the part of the surgeon and corresponding proficiency on the part of the radiographer. That some failures should have occurred does not appear to me to detract from the value of this method.
I have on two occasions failed to obtain a shadow on the first attempt. When the absence of a shadow was discovered the operation was immediately repeated and in each case was completely successful, one of the plates being as good as any that I have obtained. In both cases an opaque catheter was used and the first plate revealed the fact that the ureteric catheter had been pulled out in withdrawing the cystoscope and did not reach beyond the brim of the bony pelvis. As a result the collargol solution had escaped downward into the bladder. It is important, therefore, to use an opaque catheter and one which is marked in segments easily read by the unaided eye, so that the surgeon may know on introducing the catheter how far he has passed it up the ureter. The eye of the catheter should be within the renal pelvis and the distance which the catheter must travel up from the ureteric orifice is usually twelve or twelve and a half inches. Further, care must be taken to avoid pulling on the catheter during the removal of the cystoscope.

In a third case, the only other failure that I have had, there was an interval of over ten minutes between the introduction of the collargol and the taking of the radiogram. During this time the collargol had escaped down the urethra outside the catheter for the plates showed the catheter in good position and the collargol shadow in the bladder.

In one case I did not at first discover a shadow and thought that the collargol had failed to show on the plate. On further search I found, however, that there was the shadow of a normal pelvis lying on the shadow thrown by the ileum—and partly obscured by it. Dr. Blum states that the method is useless in closed hydronephrosis. The objection cannot be a very serious one. Completely closed hydronephrosis is in my experience a rare condition and is one in which the diagnosis is seldom in doubt. The application of the collargol method to it is rather of academic than of practical interest. In the temporary closure of an intermittent hydronephrosis the ureteric catheter after a slight hesitation passes on into the sac, the contents can be emptied, and if desired, collargol
solution can be substituted. The real use of the collargol method is not, however, in these advanced cases but in the early cases when genuine difficulty in diagnosis exists.

There is said to be danger of injecting the whole kidney tubules and of causing rupture of the renal pelvis with the collargol solution.

On examining the basis for this statement it will be found that the condition was produced on the dead body with the exception of one case (Oehlecker), where it occurred in a child of ten years. In this case the fluid was “injected under high pressure.” Were this fact not definitely stated, I would have considered it superfluous to insist upon the utmost gentleness of manipulation and delicacy of touch in everything connected with ureteral and pelvic work of this nature. If this cannot be guaranteed, the surgeon had better leave such methods alone.

I did not “inject” the collargol solution. It is run in by raising the small glass receptacle six or twelve inches above the level of the urethra.

Further, anaesthetics should be avoided as pelvic pain is a valuable guide to the surgeon and one that should receive instant attention.

Finally a fatal case has been recorded by Roessle where “cauterization of the entire mucous membrane of the kidney pelvis and inhibition of the pyramids with collargol” (Blum) was found. This case was quite exceptional.

I have operated upon a considerable number of cases within a week of the collargol injection and have found the mucous membrane of the pelvis healthy and glistening even where the contents of the pelvis were still deeply stained with collargol.

In a recent case I performed nephrectomy two days after an examination with a 20 per cent. collargol solution. Microscopic examination of the mucous membrane of the renal pelvis showed the epithelium normal in appearance.

So far as I am aware no such cauterization as that recorded by Roessle has occurred in the experience of other observers. I have to thank my colleague Dr. Ironside Bruce, radio-
grapher to St. Peter's Hospital, for the care and skill that he has devoted to the production of the radiograms illustrating this article.

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THE VALUE AND LIMITATION OF DIASTASE, UREA AND PHTHALEIN IN ESTIMATING RENAL FUNCTION IN ASSOCIATION WITH URETERAL CATHETERIZATION.

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Recently Wohlgemuth has introduced quantitative diastase estimation of the urine as a method of determining the relative functional capacity of the two kidneys. In a series of normal cases he found the diastatic activity the same, or practically the same, on each side, while in unilateral disease the diastase content of the urine from the pathological kidney was always lower than that from the normal kidney. Simultaneous determination of function by means of cryoscopy, phloridzin and indigo-carmine showed that a certain amount of parallelism existed between the findings of these various tests and the amount of diastase present. He suggests that the diastatic activity may be of value in determining the advisability of nephrectomy in certain instances.

In our previous communications the undoubted value of phthalein in these connections was demonstrated. Urea, and in certain cases indigo-carmine, phloridzin and Albarran’s polyuria test were utilized in conjunction with phthalein. Attention was called to a certain advantage which phthalein has over the other tests, viz., that it reveals not only the relative but the accurate absolute functional capacity of each kidney, thus allowing a prognosis concerning the ability of the remaining kidney to carry on unaided renal function. As
a result of these studies it was learned that the employment of all of the tests in any one case was impracticable, time consuming and also unnecessary, since the urea and phthalein furnish all available information. In a series of 40 cases the study of the phthalein output, of the urea per cent., total urea, and diastase from each kidney is here presented, an effort being made to determine the relative reliability and practicability of these tests as well as to ascertain what advantages, disadvantages and limitations pertain to each.

*The Technic Employed.*—The diastase has been determined according to the original technic of Wohlgemuth which is as follows: After neutralization, the same amount of urine from each side is placed by means of an accurately graduated pipette in a series of twelve test tubes in amounts decreasing from 0.6 c.c., 0.5–0.1–0.04 c.c. A sufficient quantity of 1 per cent. NaCl solution is then added to bring the amount of fluid in each tube up to 1 c.c.¹ To each tube is added 2 c.c. of a 1/1000 solution of freshly prepared soluble starch. The tubes are immersed in a water bath at 38° C. for 30 minutes after which they are placed in cold water for 3 minutes. To each tube is added sufficient 1/50 N. iodin solution to elicit a permanent color, violet or blue occurring where digestion is not complete. The tube in each series immediately preceding incomplete digestion of the starch indicates the diastase content of that particular urine and from this the d is calculated. 

\[ d = \text{diastatic activity expressed as the number of c.c. of } 1/10 \text{ per cent. starch solution capable of being digested by } 1 \text{ c.c. of the urine utilized.} \]

It might be emphasized that neutralization of the urine is important. In one case in which the urine on the left side was extremely alkaline, determined on the unneutralized sample, d was 4, whereas after neutralization it was 20. Although an extreme case this indicates the necessity of neutralization in every instance.

¹ One c.c. of urine was diluted to 10 c.c. and from this diluted urine the measurements of the amounts less than 0.1 c.c. were made.
Urea was determined in all of the earlier work by means of the Doremus method. In some of the later cases, however, Marshall’s new area method was utilized.

The phthalein test was utilized according to the technic described in previous communications, except that the drug was given always intravenously and collections made for 15 minutes or half-hour periods.

In forty cases fifty diastase determinations were made. The general result coincides fairly well with those of Wohlgemuth in that in the majority of instances the diseased or more diseased kidney is correctly indicated through the decreased diastatic activity of the urine from that kidney. Where the various tests harmonize no comment is necessary. One case, however, is of sufficient interest to justify a detailed report, because it afforded an opportunity for an extensive and prolonged study of function and also the opportunity to observe the effect of a pyelotomy on the function of the operated kidney, as well as the effect of this procedure and of the anæsthetic on the function of the other kidney.

There was complete blockage of the right ureter, the urine draining from a renal fistula, the result of an operation for a calculus seven years previously. The urine only from the left kidney passed through the bladder. This kidney contained in its pelvis a large calculus which was associated with a slight infection.

The total function was practically normal, 41 per cent. phthalein for one hour. All three tests indicated the left kidney to have a functional capacity double that of the right. At operation under gas and ether anæsthesia a large bifid kidney was encountered on the left side, the lower half showing a marked hydronephrosis, the upper half, healthy kidney tissue equal to the size of a normal kidney. The stone lay in the pelvis of the lower half and was removed through an incision in the pelvis (Dr. Young). Although no dissection was done to determine the exact anatomical condition present, it seemed very evident that the kidney had a double pelvis, the stone lying in the lower one, the upper pelvis entering into a common ureter below the stone and being consequently free of obstruction. This upper
hypertrophied kidney tissue explained the presence of the practically normal total function in the presence of these severe bilateral renal lesions.

The day after the operation (the right kidney not having been disturbed) the function of the right kidney dropped to one-half its previous capacity, while that of the left dropped to one-third, the function of two sides being now identical. The time of appearance from the right was 40 minutes as compared to 15 minutes prior to operation. The function of each kidney gradually improved until at the end of three weeks the level which existed previous to operation was reached.

In certain cases differences in functional capacity, as indicated by these various tests, exist, a consideration of the details of these differences furnishes information as to the relative value and limitations of each test.

In Case I there was a slight grade of pyelonephritis of the right kidney and some hydronephroses. The phthalein indicated the function of this kidney to be half that of the left, while the total urea indicated identically the same ratio. The diastase, however, showed a very much greater function on the left than on the right side, and when the greater quantity of urine from the left side is considered this disproportion would be even more exaggerated. The phthalein and total urea appeared to be more in accord with the clinical findings. In this instance the urea per cent. was of no value.

While from our results it is quite evident that differences in diastase are not so readily caused through dilution as differences in urea per cent., dilution in relation to diastase is not a negligible factor as is exemplified by one of our cases. In Case XI, a slight left-sided pyelitis, the phthalein was equal from the two sides, indicating equal function. This was corroborated by the total urea. The diastase showed a marked difference on the two sides. But if corrected for dilution the total diastatic activity would be practically equal.

In the presence of an unmistakable tuberculosis of the left kidney (Case XXXVI) in which the decreased function was indicated by phthalein, urea per cent. and total urea, the
diastase failed to reveal any differences in function. Total diastase, however, would be more in accord with the true functional condition, but this furnishes no information other than is available from phthalein and urea. Case XXVII is another instance of the same phenomenon.

In two other cases which clinically presented no signs or symptoms of renal disease, a marked difference in function on the two sides was indicated (Cases XIV and XX).

These six cases serve to demonstrate that diastase is not an infallible index of relative functional capacity, since in two apparently normal cases considerable differences existed between the two sides, in two cases a definite lesion was not indicated, in another the functional injury was exaggerated, while in the sixth case unless the quantity of urine was taken into consideration an erroneous impression of function was given.

The diastase is of very considerable value, however, in the majority of cases. It is about equal in value to urea per cent. In some cases it may be of even greater value than urea per cent. because of the fact that it is not so readily affected by dilution. In the cases of free urinary secretion, which are usually cases without ureteral inhibition, the phthalein gives much more accurate information and in such cases diastase and urea are of minor value only.

The employment of functional tests in association with ureteral catheterization is attended with two great difficulties which in certain cases make it impossible to obtain all desirable information from any one test: (1) Inhibition of function and (2) leakage around the ureteral catheter.

1. Inhibition.—Any discrepancy due to inhibition can be detected readily through the determination without ureteral catheterization of total renal function by phthalein and error can thereby be avoided. For instance, with a total phthalein excretion normal or nearly normal, one kidney at least is normal or practically so. If, in such a case, on ureteral catheterization one should find on one side decreased function, which under ordinary conditions would be an indication for
nephrectomy even though the function of the supposedly healthy kidney as estimated with the aid of the catheter showed an apparently dangerously low excretion on account of the inhibition, one need not hesitate about removing the diseased kidney. The low function here is clearly the result of inhibition, the extent of which is indicated by the discrepancy between the separated functions and the total function without ureteral catheterization.

In cases of bilateral tuberculosis, the amount of pus from each side being practically the same, the phthalein can demonstrate that one kidney has a function far in excess of the other—a function sufficiently good to allow of successful nephrectomy. However, in certain instances inhibition might be so marked and the elimination of phthalein from each side consequently so small that it might be impossible from phthalein alone to determine which is the better kidney. Here diastase and urea per cent. together with a difference in the intensity of urine pigment and a consideration of the total phthalein would be of value. No such instance, however, has yet been encountered. In the majority of cases the influence of inhibition can be minimized through longer collections (½ to 1 hour).

Occasionally owing to extreme nervousness on the part of the patient or on account of unusual pain attending the presence of the catheter in the ureter, the time of catheterization must be curtailed to such an extent that an accurate quantitative determination of function is impossible. Here one is obliged to secure all of the necessary information from microscopical and clinical data and from urea per cent., time of appearance of phthalein and possibly of diastase, provided sufficient urine has been excreted to allow the application of the tests.

2. Leakage.—In order to obtain an accurate quantitative estimation of the function of each side it is necessary to secure complete collection of the urine. By the use of Albarran’s flute end catheter this is usually possible. In a certain proportion of cases, especially those with relaxed ureters, leak-
age does occur and sometimes in amounts sufficient to nullify the findings. Unless one repeats the catheterization, which is not always practicable, using the Garceau catheter on one side along with transvesical collection for the other, knowledge of the relative functional values must be largely obtained from urea per cent., diastase and time of appearance of phthalein. This was well illustrated in a case with normal kidneys in which so much leakage occurred that the estimation of the relative function from phthalein was impossible, but the diastase, urea per cent. and phthalein appearance time all indicated identical functional capacity on the two sides.

Combination of Tests.—The number of tests has increased to such an extent that the use of all of them is impracticable. It becomes necessary, therefore, to consider what tests are really necessary for all of the available information under all conditions. In order to make a judicious selection it is necessary that one be familiar with the peculiarities, advantages, disadvantages and limitations of each and all of the approved tests.

Interpretation of findings is not always easy but in order that this may be made simpler, our ideas relative to the indications for the employment of any one of these tests alone or in combination, together with the significance of their findings, are here presented.

The phthalein test is incomparable so far as total function is concerned and gives information frequently unavailable from any other source, and in cases in which leakage and inhibition are absent furnishes in itself all the information necessary in regard to the function of each kidney. The absolute on each side as well as the relative function is revealed.

It is advisable to give the phthalein intravenously and to make collections for one-half to one hour periods when an accurate quantitative knowledge of the function of each kidney is desired, because as was previously pointed out, short periods of collection are not reliable. In the majority of in-
stances, however, where it is necessary only to ascertain if the remaining kidney has a sufficiently good function to warrant operation, shorter periods (15 minutes) suffice.

In exceptional cases where marked inhibition or severe leakage occurs, diastase and urea per cent. may furnish most important information in conjunction with microscopical and clinical data. Diastase is subject to the same errors as urea per cent. except that it is not so readily influenced by dilution. The findings of either must be accepted with extreme caution and only when, for causes mentioned above, total urea and quantitative phthalein determinations are impossible.

The method of procedure which has furnished the greatest amount of information is as follows. In all cases demanding ureteral catheterization the total functional capacity is first determined by phthalein without ureteral catheterization. Where the total function is low a cryoscopy of the blood serum or a blood urea determination is made (Marshall's method). After ureteral catheters are in place and a flow of urine has become established the phthalein is given intravenously and the time of appearance on the two sides noted. Urine is then collected for periods of from 15 minutes to 1 hour starting from the first appearance of the drug, the length of the period depending upon the character of the information desired. Where leakage or inhibition of a grade sufficient to interfere with quantitative determinations does not occur, the quantity of phthalein from each side during a period of 15 minutes or preferably one-half hour is considered the index of the function of the individual kidney.

Total urea estimations almost invariably corroborate the findings of the phthalein as regards the relative function.

In the presence of considerable leakage dependence is placed upon the time of appearance of the phthalein, urea per cent. and diastase.

In the presence of inhibition the urea per cent. and diastase are the factors of greatest value taken in conjunction with the clinical findings.

Practicability of Tests.—The phthalein and Marshall's urea determinations are made with great ease and take but
little time. The diastase while exceedingly simple is time consuming. Freshly prepared soluble starch solution is needed anew each day and at least a half hour actual time is necessary for each test.

CONCLUSIONS.

1. That diastase is of value in the majority of cases in indicating which is the diseased or more diseased kidney.

2. That in the majority of instances it is not necessary and adds nothing to the information obtainable from the phthalein or urea determinations which are more easily made.

3. That in cases with leakage or serious catheter inhibition, but where sufficient urine to allow a diastase determination has been obtained, the test is of value.

4. That dilution affects the urinary diastase content to a less extent than it does urea per cent.

5. That dilution is not a negligible factor in regard to this test, total diastase content being at times of greater importance.

6. That neutralization of the urine is not a negligible factor in the technic of the test.

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REPORT OF A CASE OF PELVIC KIDNEY:
DIAGNOSIS BEFORE OPERATION.

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(Reported from the Mayo Clinic.)

As a means of diagnosticating congenital anomalies of the urinary tract the radiogram, following the injection of colloidal silver, is of great value inasmuch as it demonstrates accurately the position, size and number of kidneys, and the condition of the ureters. The following case report is an example in which this method was used and the diagnosis made before operation.

**Case A75609.**—Mrs. P., aged thirty-two, married. Fourteen years previously the patient had been examined in the Mayo Clinic. At that time she had not menstruated. Physical findings: Vagina about one inch in length. No uterus, ovaries or tubes were discoverable upon palpation. Breasts normal and well developed. Family history: Eight sisters all having normal menses, five of them had married and borne children. Present history: Married seven years. No menses, but distress and pain over the region of the ovaries every two months. A year ago, following a cold or wet feet, she began to have attacks of frequent micturition. These attacks lasted six or seven days and then disappeared. She complains of a low abdominal pain, alternating from one side to the other, and she has been confined to bed for two or three days at a time with marked soreness and tenderness in the left pelvis. In sitting down and flexing the left thigh, and in leaning over, she has a severe sticking pain in the left side. She does not sleep well, cannot lie on her left side, is nervous and tires easily. Examination of urine (12 hour specimen): Specific gravity, 1018, 350 c.c., acid, no albumen, no sugar, an occasional red-blood cell. Objective symptoms: Vagina one inch long. No uterus palpable. Rounded mass about the size of an orange high in left inguinal fossa,
tender to the touch. Slight thyroid enlargement. X-ray negative. Patient well nourished, but nervous.

Because of the congenital anomaly of the genital organs without history of menstruation, the patient was referred for cystoscopic examination. Cystoscopy showed the urethra and

FIG. 1.

Outline drawing of radiogram following injection of colloidal silver into the kidney and ureters. Note position of left kidney in bony pelvis. Normal position of right kidney.
bladder to be normal. It was difficult to pass the left ureteral catheter more than 5 cm., or 2 1/4 inches from the bladder. The right side appeared to be normal. Amount and character of the urine from the left side compared favorably with that from the right side. A double injection of colloidal silver by the gravity method was made and a radiogram taken. The passage of the cystoscope and the left ureteral catheter was so painful to the patient that the operation could not be prolonged long enough to give an intravenous injection for the purpose of making a separate estimate of the function of the two kidneys.

Fig. 1 shows the pelvis of a hydronephrotic kidney lying well down in the left bony pelvis. The ureter was 3 1/2 to 4 1/2 inches in length. The pelvis of the kidney was upward and inward from the cortex, and the ureter's course upward and outward then downward and inward. The position of the other kidney and the outline of the pelvis, normal.

The patient was operated on November 18, 1912, by W. J. Mayo. The position of the kidney was found as shown in Fig. 1. The pelvis was hydronephrotic and infected; the ureter about 4 inches long. The blood supply to this kidney came from two or three renal arteries from the left common iliac about one-half inch below the division. The renal vein entered the vena cava just at the bifurcation and was closely adherent to the kidney-mass. All of the left external iliac vein could not be found. It may have become fused with the internal or it may have been very small, due to the pressure of the adherent kidney.
MYOMA OF THE STOMACH.

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Tumors of the stomach, other than carcinoma, have been somewhat infrequently reported. Sarcoma is the most common; there are now over two hundred cases in the literature (Zeische and Davidsohn¹ and Briggs²). There are many specimens of papilloma and adenoma of the stomach in collections; they have largely been secured at autopsy and seldom have clinical significance. Lipoma³ and fibroma⁴ have been recorded. Leiomyoma of the stomach is much rarer. We have recently had a case of myoma of the stomach the record of which follows:


C. P., male, nine years old, the second child of his mother, was first seen on May 31, 1912. His father and mother were healthy; they are third cousins. They have one other child who is perfectly healthy.

The patient had an attack of erysipelas at the age of one and one-half years; and at the age of six a small right inguinal hernia was noticed which subsequently disappeared.

Otherwise he had always been healthy until two years ago, when he began to vomit at frequent intervals for days at a time. The vomiting was accompanied by general abdominal pain. During an attack of vomiting he was confined to his bed; between attacks he was up and about, leading the ordinary active life of
MYOMA OF THE STOMACH.

a boy of his age. Hämatemesis occurred once or twice at the end of an attack of excessive vomiting; he at no time vomited more than a half spoonful of blood. He did not lose much weight, but he was quite weakened. The bowels had been kept regular with cathartics.

**Physical Examination.**—On entering the hospital, May 31, 1912, he had a temperature of 97.4° and a pulse of 90. He was a pale, undersized boy. His hemoglobin was 70. His heart and lungs showed no evidence of disease. His urine contained no albumin or sugar. A visible palpable tumor apparently the size of an orange presented in the upper portion of the abdomen above the umbilicus and in the midline. It was not tender.

June 1, 1912. Laparotomy was performed. The tumor was a smooth soft mass extending from the pylorus 8 cm. over the anterior and posterior walls and projecting into the lumen of the stomach. No enlarged lymphatics were felt. On account of the age and condition of the patient a two-stage operation was considered advisable. Gastro-enterostomy was done at this time and the patient's physician was told to return with him in from three to six months for excision of the mass.

The patient made an uneventful recovery from the first operation and seemed perfectly well for two months. He then had several attacks of vomiting at intervals of about a month which weakened him considerably, but at the time of his second entrance to the hospital on February 1, 1913, he appeared in fair physical condition. There was a small chain of palpable inguinal lymphatics on both sides not noticed in the previous history. On February 4, 1913, the abdomen was again opened. The tumor had apparently not increased in size. No glands were felt in the region of the lesser or greater curvature. Gastrectomy was performed; it was necessary to remove about one-third of the stomach in order to encompass the mass, which was excised. The patient again made an excellent recovery. He was discharged from the hospital two and a half weeks later in good condition. His temperature and pulse were normal. He was eating six small meals a day. Since then his progress has been very good. Two months after the operation he had gained twelve pounds in weight.

**Macroscopic Appearance of the Tumor.**—The tumor was 8 cm. in length by 6 cm. in thickness. It weighed 341 gms. It exactly occupied the site of the pylorus, extending for half its length along the greater
curvature and front and back walls of the stomach. Fig. 1 is a side view of it with the pylorus cut open, the surface of the gastric mucosa above. Fig. 2 shows the mass bisected and the cut surfaces of the two halves. The dark spot at the lower pole is a cyst with smooth walls which was filled with brownish fluid. The white surface above this was firm and dense. The gastric mucosa was everywhere intact and freely movable over the surface of the tumor. The serosa also was intact and movable so that the neoplasm occupied the middle coats of the stomach.

**Microscopic Appearance.**—Sections made through the firm white part of the tumor showed everywhere parallel bundles of smooth muscle fibres interlacing in all directions. In many parts there was some rounded-celled infiltration between the individual fibres. Although all relations here were lost it must have sprung from the muscular coat. With the Van Gieson stain it was seen that although there were many fibrous elements the muscle cells were in great preponderance (Figs. 3 and 4).

On February 21, 1913, he was given a bismuth meal and its progress watched with the X-ray. The bismuth entered the stomach very slowly and remained for some time above the cardia, trickling into the stomach slowly. After its entrance it settled in six to seven minutes in the lower pole of the stomach in a small mass and then began to leave the stomach by the gastro-enterostomy opening. Respiration facilitated the passage of the food into the intestine. The stomach was nearly completely empty in twenty minutes. Fig. 5 is a plate taken at the time the bismuth was beginning to leave the stomach after a second glass of butter-milk containing bismuth oxychlorid.

The literature upon myoma of the stomach is not large. The earliest collective report we have found is Steiner's, who reported twenty-one cases of myoma and myofibroma of the stomach. Thompson was able to collect forty-three cases which had only pathologic interest, and twenty cases of clinical interest. Of these, two (Moser's and Capello's) are reported as myosarcomata. Thompson then had eighteen clinical cases of leiomyomata or fibromyomata. To these he added one operated case.

Kosinski's case is the earliest reported—a male aged fifty-seven who had a tumor in the abdomen with symptoms extending over three years. Three days after aspiration of fluid from the abdomen he collapsed and died. At autopsy a tumor weighing twelve pounds was found attached to the greater curvature.
FIG. 1.

Appearance of the tumor, with pylorus cut across; the mucosa is above.

FIG. 2.

Section of the mass.
Microphotograph of a section made in the dense part of the tumor. (Low power.)

High power of a portion of Fig. 3.
Study of the stomach with bismuth meal.
Rupprecht performed gastrectomy on a male aged fifty-two for a myoma weighing 251 grammes. Von Erlach removed a stomach in a woman, thirty-four, with a leiomyoma weighing 5400 gms. The patient recovered.

Von Eiselsberg excised a fibromyoma of the stomach in a woman aged thirty who recovered. Nicoladoni reported a fibromyoma in a man aged sixty.

Herhold had a patient, female aged thirty-seven, who was operated on for persistent vomiting. She had a myoma at the pylorus the size of a hazel-nut. Bland-Sutton reports a pure myoma found on the posterior wall of the stomach during an operation for gall-stones. Poirier reports a cherry-sized myoma at the pylorus in a woman fifty-eight. Sainter had a female patient forty-nine years of age who complained of nausea and emaciation. She had no palpable tumor but at operation a myoma was found at the pylorus: gastro-enterostomy resulted in recovery. Delore's patient had a palpable tumor, a leiomyoma; he died two years after a gastro-enterostomy. Gouillioud's patient was a male aged forty-four who had a tumor in the right hypochondrium. It proved to be at the pylorus. Pylorectomy and gastro-enterostomy were done. The patient was well six months later. Histologically the tumor was a leiomyoma. Ochsner's case reported by Yates was a male aged seventy-three who was operated on for distress in the epigastrium. There was no palpable tumor. A tumor the size of a walnut was removed from the posterior stomach wall. It proved to be a myoma. Cholecystectomy was also done. The patient was well one year later.

Goebel's case was a woman sixty-nine years old who suffered from an abdominal tumor and emaciation; a leiomyoma of the anterior wall of the stomach was removed. The patient died.

Thomson's case was a woman aged forty-two. Four years after operation she vomited blood and passed tarry stools. She fainted many times during the four years and always passed tarry stools for days after a fainting spell. Later she suffered from pain in the epigastrium and emaciation. There was no palpable tumor. Operation revealed a large tumor growing from the posterior wall of the stomach. Partial gastrectomy and gastro-enterostomy were done. The patient was well six months later and had gained thirty-five pounds.

Hake added three cases found in autopsy material; all small annular myomata at the cardia. Ferguson catalogues a myoma of unusual size at the cardia. Shuyeninoff reports two cases of malignant leiomyoma of the stomach. Battey reports one case in a woman sixty-five years old; a diagnostic puzzle which proved at autopsy to be a suppurative leiomyoma of the cardia. Foulerton describes a specimen removed by Bland-Sutton evidently the same as described by him in a separate article. Spencer reports a case in a woman aged forty-six who had a large submucous tumor which proved to be a fibromyoma. He mentions in his paper another case operated upon by another surgeon:
the tumor was the size and shape of a small sausage and sprung from the greater curvature; at operation it was supposed to be an intussusception and removed with a part of the stomach; the surgeon discovered his mistake and reopened the abdomen but the patient died.

Peugniez and Jullien report two cases: one in a woman aged thirty-seven who for five years had attacks resembling acute appendicitis; at operation a small hard myoma was found at the pylorus, which was excised with recovery. The other was of a woman aged fifty-seven who had had symptoms of pyloric obstruction at the age of twenty-two and at the time of presenting herself for operation had vomiting, epigastric rigidity and retention of food. A diagnosis of gastric cancer was made and a laparotomy revealed a hard tumor encircling the pylorus; a pylorectomy was done and resulted in a recovery.

Mouriquand and Gardere had a patient aged sixty-seven who entered the hospital for oedema and cardiac irregularity and died in a uremic convulsion; at autopsy a large myoma was found on the posterior wall of the stomach.

Lowit operated upon a woman forty-eight years old who suffered with diffuse abdominal pain. An elastic tumor presenting in the hypogastrium had been noticed for a year gradually growing until at the time of examination it was the size of a man's head. On opening the abdomen a cystic tumor containing 1.5 litres of fluid was found attached to the greater curvature near the pylorus. Microscopically it was a lymphangiectatic myoma. The patient left the hospital in two weeks.

Bullock reports two cases in females aged sixty-three and fifty-six.

Anitschaff reports three museum specimens all located at the junction of the stomach and esophagus.

Farr and Glenn report a case in a woman aged forty-nine who had profuse hematemesis and died shortly after. At autopsy a myoma was found in the fundus of the stomach. Farr and Glenn collect 84 cases but they include many cases of adenomyoma and myomata in association with carcinoma; all the reports of this sort that we have investigated have been of doubtful value.

There are then seventy-nine cases now on record including the one here reported. Of these twenty-eight have come to operation, or have been of clinical interest. The condition is usually considered to be carcinoma before operation and sarcoma at operation, until the microscopic examination is made. Sherren, in collecting eighteen cases of polypoid tumor arising from the greater curvature of the stomach, states that often they are myoma malignum, and present as cystic tumors in the midline. These cases are similar to the cases of Kasinski, Lowit, Battey and Spencer.
MYOMA OF THE STOMACH.

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PRIMARY SARCOMA OF THE LARGE INTESTINE.*

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Statistics.—A somewhat careful survey of the material at my disposal shows a dearth of literature upon this subject until quite recently. According to Baltzer,1 Stort found no cases in the reports of the Berlin Pathological Institute from 1859 to 1875. Undoubtedly many of the early cases were confused with other conditions and thus remained unrecognized.

Jopson and White,2 in 1901 (American Journal Medical Sciences, v, 122), after a careful review, were able to find only 22 cases of sarcoma of the large intestine; and in 5 of these there was some doubt as to the growth being primary in the large bowel. In only 14 cases was the growth confined to the large bowel exclusively. Only 3 of this group were confined to the cæcum and ascending colon.

Location.—While in carcinoma of the intestine perhaps 95 per cent. occur in the large bowel, in sarcoma only about 35 per cent. are found there.

Corner and Fairbanks* collected 175 cases of sarcoma of the alimentary tract (exclusive of the mouth, pharynx and anus), with the following distribution: ceophagus, 14; stomach, 58; small intestine, 65; ileocecal, 20; colon, 11; rectum, 7.

G. A. Hamann (Surgery, Gynecology and Obstetrics, September, 1909), in 1909, was able to find 4 additional cases.

We could only find 3 cases of sarcoma of the cæcum and ascending colon reported up to the time that I operated upon my case. The colon is most apt to be affected in childhood.

W. J. Mayo* in 1909 reports resecting twice for sarcoma of the intestine, in a paper on “Tumors of the Cæcum.”

S. Goto, in June, 1911, collected 24 cases of ileocecal sarcoma, exclusive of those of the appendix, and gave 1 of his own. He gives 5

* Read before the Minnesota Pathological Society, March 18, 1913.

818
cases reported by Nothnagel, 2 by Frank and 3 by Baillet, making 32 in all up to June, 1911, which is the last report I can find.

A. Baer found 10 sarcomas in 124 inflammatory tumors of the ileocecal region.

Pathology—Microscopic.—Whereas all varieties are found, the most frequent type is the round cell; and perhaps the lymphosarcoma is second in frequency.

Jopson and White report only one spindle-cell tumor in the twenty cases where the type was known.

The tumor probably usually begins in the submucosa, and may be pedunculated, or may infiltrate the bowel wall, causing great thickening; but does not often involve the serosa. Tendency to stenosis is not marked; and, indeed, dilatation may occur. The growth has a tendency to develop longitudinally in the bowel wall, and has not the predilection for points of irritation which is so often manifest in carcinoma. The abdominal lymphatics are apt to be involved early and extensively, and metastasis here is most frequent. Perhaps the peritoneum is next. The actual diagnosis cannot be made except with a microscope.

Incidence of Sarcoma as Compared with Carcinoma.—These growths, while having much in common clinically, have many distinguishing features which are unlike; but a classification of symptoms which might point to more than a probable diagnosis is impossible.

Generally speaking, sarcoma appears in younger individuals, grows more rapidly, and is more apt to show tumor. Wasting and anemia are more marked, and pain is out of proportion to obstructive symptoms. Early cachexia and less liability to stenosis and to hemorrhage, and perhaps irregular fever are the most distinguishing features of sarcoma.

Treatment.—Excision offers the only hope. Glandular involvement is no contra-indication. So far results have been discouraging.

Corner and Fairbanks' statistics show a mortality of 33 per cent. in 51 resections. Of 11 resections in the large intestine, 7 survived the operation. Fourteen of 22 cases
reported by Jopson and White were explored, and only 10 could be resected. Of these 5 died. Two cases of the 11 sarcomas of the colon were resected and both died.

Involved abdominal lymphatics should be looked for, and removed; and in cæcal growths the rule of excising at least six inches of the terminal ileum should be followed, as its lymphatic drainage is identical with that of the colon.

Report of Case.—Mr. A. S., aged sixty-one, had been under the care of Dr. L. A. Nippert for acute inflammatory symptoms relating to the right upper abdomen during the previous two weeks, during which time he was confined to bed. This was the first attack of this kind that he had ever had. He describes his previous attacks as follows:

For about twenty years, with gradually increasing frequency, he had had attacks of partial obstruction, and after severe pain, and often vomiting, he would take a laxative and finally be relieved. There had never been any bleeding, but the stool had been dark at various times. Microscopic examinations for blood, by various physicians, had proven negative. A year or two previously a small tumor had been removed from the face, and pronounced by Dr. Corbett, who examined the growth, to be adenoma.

The skin presented a marked icteric tinge which was thought to be due to the gall-bladder condition. Local examination showed much rigidity in the right upper quadrant; and on deeper inspection a mass could be palpated in the right kidney region. The urine showed albumen, granular and hyaline casts, and decrease in quantity.

Operation.—Operation revealed a distended gall-bladder, greatly thickened, which was quickly drained, as the intestinal tumor had been explored and found to be operable. A classical resection, with lateral anastomosis by the method of Moynihan, was made. Several large glands were lifted out, with the growth, after mobilizing the bowel after the method of Lane. Drainage was employed on account of the gall-bladder infection.

The output of urine was 32 ounces during the succeeding four days; but convalescence was otherwise normal. Since that time his health has been excellent.
Photograph of gross specimen sectioned longitudinally. The sharp limitations of the tumor, the nodular projecting masses, the thickened walls and the absence of ulceration are the prominent features.

Microphotograph, times 500. Shows a fine fibrillar net-work with numerous rounded and oval nuclei.
Microphotograph, times 300. Area showing numerous thin-walled vessels with slightly denser connective tissue bundles.

Microphotograph, times 400. Section of mucosa of colon with underlying tumor; submucosa is replaced by dense tumor tissue which has advanced to the bases of the mucus glands.
FIG. 5.

Microphotograph, times 900. Enlarged view of thin-walled capillary with surrounding tumor cells, some of which show mitotic figures.

FIG. 6.

Microphotograph, times 1000. Showing characteristic arrangement of tumor cells which have vesicular nuclei of irregular size, shape and staining reactions. The fine intercellular fibrilæ are represented in upper right hand corner.
Microphotograph, times 700. Section of adjacent lymph node showing tumor metastasis in sinus.

**FIG. 7**

Points at which the intestine was divided.

Points of lateral anastomosis.

**FIG. 8.**

**FIG. 9.**
He now weighs 200 pounds and his bowels move normally. The tumor involved almost all of the ascending colon, but its thickest point was at the cæcum, and it probably began here.

Pathological Report (by Dr. H. E. Robertson, of the University of Minnesota).—Gross specimen consists of cæcum with portions of ileum and ascending colon. In its preserved state the ileum portion measures 25 cm. in length. At the ileocecal junction is an irregularly lobulated tumor mass, sharply defined on either side and occupying the proximal 6 cm. of the cæcum and ascending colon. A portion of the ascending colon, 6 cm. in length and apparently normal, projects beyond the confines of the tumor.

The walls of the bowel are infiltrated by tumor, reaching a thickness of 1.5 cm. Masses of tumor tissue also project into the lumen of the bowel, almost totally occluding it. In fact, it was found that water poured into the cæcum could not without great difficulty be forced through the tumor area.

The tumor sections with the resistance of fibrous tissue and is very firm. It is everywhere covered by intact mucosa, there being no evidence of ulceration or necrosis. Its cut surface has a grayish-white, glistening appearance. A few firm, enlarged lymph nodes are present in the neighboring mesentery and mesocolon. The appendix measures about 8 cm. in length and is apparently normal.

Microscopically, the tumor is composed of a very cellular connective tissue stroma in which are varying sized groups of strands and bundles of fibrils with many rounded and oval nuclei of varying size. Thin-walled capillaries are abundant. The tumor tissue invades the submucosa and lies immediately adjacent to the mucous membrane. There are a few microscopic areas of necrosis. In some portions connective tissue fibrillae are almost entirely absent and large numbers of rounded nuclei with irregular masses of chromatin are present. Alongside of some of these cells tiny fibrillae may be distinguished by special stains. Mitotic figures are fairly common. Numerous eosinophiles and lymphocytes infiltrate the tissue spaces.

Microscopic examination of one of the adjacent swollen lymph nodes shows the node invaded by tissue resembling in every respect that found in the parent tumor.

Diagnosis.—Round-cell sarcoma of cæcum and ascending colon with metastasis to neighboring lymph node.

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NON-ROTATION OF THE INTESTINE.*

ITS RELATION TO HIGH, RETROCECAL AND ABERRANT POSITIONS
OF THE APPENDIX.

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The frequency with which one meets, in operating, the abnormally placed appendix, and the difficulties encountered in dealing with it, often through a badly placed incision, seem to warrant a review of the subject.

The most frequent variation is the "retrocecal" appendix. By this I mean an appendix actually extraperitoneal, in whole or in part, by reason of secondary adhesion in the process of development, and not extraperitoneal as a result of segregation by a protective peritonitis.

Rarer forms are those where we find the appendix in the region of the liver, approximating the median line, or in the left iliac fossa. In these latter, more advanced forms of arrest of development, we are apt to find the ileum entering the cæcum on the right side.

The difficulties of these cases are further increased by failure in early diagnosis. They come to the hospital late through lack of prompt recognition, or we, beset by the same difficulties of diagnosis, fail to give the prompt relief demanded. We have in consequence to deal with an inflammation far advanced, with bowel and mesentery unduly thickened, rendering the gut difficult of manipulation.

The extraperitoneal retrocecal forms fail to give us the telltale symptoms of peritoneal involvement, with its characteristic rigidity of the adjacent abdominal wall.

Some of us have observed cases of well advanced peritonitis, where we have failed to elicit the symptom of abdom-

* Read before the New York Surgical Society, October 9, 1912.
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inal rigidity. On opening the abdomen in such a case, the explanation has been found in the fact that the inflammation has been confined chiefly to the visceral and mesenteric peritoneum.

Dr. Charles N. Dowd has recently emphasized this symptom in an article in the *American Journal of Surgery*, June, 1912, entitled "Some Peculiarities of Deep-Lying Abdominal Inflammation." He summarizes as follows: The parietal peritoneum, supplied through the peripheral nervous system is rich in sensation, while the visceral peritoneum, deriving its nerve supply from the sympathetic system has no nerves sensitive to pressure, heat or cold.

The failure of deep-seated appendicitis to conform to the classical train of symptoms, which renders diagnosis comparatively easy, and the mistakes into which I fell, by this same failure, aroused my interest in this subject.

Among my private and hospital cases of appendicitis I find ten of abnormally placed appendix. Nine retrocecal, and one where the appendix abscess was in contact with the liver. This last I will describe in detail.

**Case.**—Albert K., son of Italian parents, five years old, was admitted to the first surgical division of Bellevue Hospital on August 1, 1912. Nine days before was taken sick with pain in the upper abdomen. Vomiting kept up all the first night. A private physician gave him some medicine which relieved him for the time being. Two days before admission pain became worse, and he was confined to the bed. Pain was of a cramp-like character. Bowels moved daily. On admission, temperature 103°, respirations 28, pulse 140, leucocytes 4300, polymorphonuclears 85 per cent. Tenderness over whole of right side. Right rectus held rigid. Abdomen not distended. Maximum rigidity, right upper quadrant.

Diagnosis, high appendicitis.

**Operation (August 1).**—Right rectus incision above level of umbilicus. Transverse colon presented in the wound. This and parietal peritoneum seemed normal. No free fluid. On further examination a mass was felt in contact with the liver,
which on investigation proved to be an appendix abscess walled in by the cæcum and the ascending colon. The cæcum was bent on the ascending colon in the form of the capital letter J. Cæcum to the right of ascending colon, parallel to it, and pointing to the liver. The appendix, gangrenous, lay in the sulcus formed by the cæcum and ascending colon. Small intestine lay behind these structures, whether duodenum or a coil of the ileum, I was unable to determine. The gut was so thickened and infiltrated that it was impossible to treat the remnant of appendix other than by the introduction of cigarette drains to the bottom of the abscess cavity. A foul discharge continued for several days, and it was feared that a fecal fistula would develop. Fortunately this did not occur. Pathological report on the small piece of appendix we were able to remove was gangrenous appendicitis. An X-ray of the colon was obtained subsequent to his recovery (Fig. 1).

A detailed description of the retrocecal cases is not necessary, except to emphasize the difficulty in early diagnosis, for the reasons above stated.

Dr. Charles H. Mayo (Medical Record, March 2, 1912) reports five cases of ascending colon on the left side, or approximating the median line. Three were operated upon for left-sided appendicitis. Two with acute abscess.

From this brief review it will be seen that this condition of abnormally placed appendix, while not common, does confront us in a certain small percentage of cases.

The correct interpretation of these various positions of the appendix is only possible, by a study of the embryology of this part of the intestinal tract. Each of these positions of the intestine, which we think of as abnormal, has some stage of embryological development, or some prototype in comparative vertebrate anatomy, as its explanation.

While it is impossible to trace each step of development in human embryology, yet by the aid of comparative anatomy, we are able to follow the picture with great surety.

The earliest indication of the alimentary tract is that of a straight tube attached to the axial mesoderm by a dorsal
NON-ROTATION OF THE INTESTINE.

mesentery. From this primitive mesentery all the other mesenteries, omenta and peritoneal folds of the adult are derived by further development, displacement and adhesion, with the exception of the anterior mesogastrium. The anterior or ventral mesogastrium is the remnant of the mesothelial layers, which extended between the ventral abdominal wall and the ventral border of the intestine, just after the splanchnopleure and the somatopleure have closed to form the alimentary tube and the body cavity. This primitive partition is lost below the stomach.

The intestine in the very earliest stage follows the body curve, later a loop is seen projecting toward the umbilicus where, by means of the vitello-intestinal duct, it communicates with the yolk-sac. We distinguish a descending limb and an ascending limb.

The cæcum bud appears about the sixth week. It shows an unequal rate of growth. The terminal piece not keeping pace with the proximal portion forms the appendix. The proximal portion is developed into the cæcum proper. Owing to its rapid growth the ascending limb of the loop, which forms the major portion of the small intestine, is thrown into folds. This very rapid growth of the small intestine forces the slow growing large intestine into the line of least resistance, i.e., toward the median line and the ventral abdominal wall, forcing it gradually upward toward the cephalic end of the abdominal cavity. This occurs about the end of the third month. At the fourth month the cæcum moves to the right, touches the caudal surface of the liver ventrad of the duodenum. The rapid growth of the liver during the placental stage of its circulation, forces the cæcum caudad, past the right kidney to its adult position in the right iliac fossa.

This progression of the cæcum and ascending colon from below upward, from left to right, and finally downward, is accomplished by the twisting, of all the gut and mesentery embraced in the umbilical loop, on its duodenocolic isthmus, or on an axis running from the umbilicus to the superior
mesenteric artery. The cæcum and the ascending colon under
the pull of the small intestine, has undergone a rotation on
its long axis of a hundred and eighty degrees. This is well
shown by tracing the muscular longitudinal bands of the
ascending colon into the transverse colon.

Take for example a piece of rubber tubing to represent
the ascending and transverse colon. Place upon it three lines
to represent the longitudinal bands of the intestine. Let them
be marked distinctively, so that, in whatever way you twist
the tube, they may be distinguished, one from another. The
attached, posterior, or mesenteric border of the embryonic
gut is the site of the "posterior band."

Hold the portion of the tube, which we have denominated
transverse colon, in the anatomical position, the posterior
longitudinal band cephalad; the so-called "anterior band"
will lie ventrad, and the "inner band" will lie dorsad.

Bend the tube at what would be the hepatic angle, and
twist that portion representing the ascending colon on its
long axis, from left to right through one hundred and eighty
degrees. It will be found that the longitudinal bands will
assume the position we call normal in the ascending portion of
the colon. The "anterior band" external, the "inner band"
anterior and internal, the "posterior band" posterior and
internal. The right leaf of the ascending colon unites with
the parietal peritoneum on the right side, and the left leaf of
the descending colon unites with the parietal peritoneum on
the left side of the abdomen. In this way the normal adult
type of peritoneal arrangement is brought about.

The accompanying illustrations (Figs. 2–10), kindly loaned
me by Professor George S. Hutington, from his volume on
The Anatomy of the Peritoneum, will better illustrate the
points in development.

From a review of these figures we see we can derive all
the forms of abnormally placed appendix. Arrest of develop-
ment may halt the cæcum and ascending colon at any point
in its progression from left to right. Failure of the intestine
to rotate on its duodenocolic isthmus leaves the colon to the left
Long arrow points to cæcum. Short arrow to coils of small intestine.
Fig. 2.

Schema of human embryonic intestinal canal after differentiation of large and small intestine.
Schematic representation of the development of the mesentery of the umbilical loop.
Fig. 4.

Schematic representation of alimentary canal, with umbilical loop and mesenteric attachments in human embryo of about six weeks.

Stages in intestinal rotation.
Abdominal viscera of the little ant-eater, seen from the left, with the intestines turned to the right.
Abdominal viscera of the little ant-eater with the intestines rotated to correspond to the development in the human subject.
Abdominal viscera of adult human female, in a case of arrested rotation of the intestines.
Abdominal viscera of adult human male, non-rotation of intestine. ileum entering on the right side of cecum.
Abdominal viscera of a child, two years old: non-rotation of intestine. Ileocolic junction on right side, appendix almost in the median line.
Human foetus at term; abdominal viscera hardened (in situ); non-rotation of cæcum.
and small intestine to the right. A partial failure of this rotation, the small intestine having failed to withdraw all of its coils from behind the caecum, will leave the appendix in a retro-caecal position, there to become buried by subsequent adhesion.

CONCLUSIONS.

The unusual and aberrant positions of the appendix have for their explanation, a stage of embryological development, there arrested; or an evidence of atavism to some prototype in comparative anatomy.

The clinical findings, in the case mentioned above, are of value as supplementing anatomic and post-mortem findings.

The approach to the appendix, in the retrocaecal types, after the abdomen has been opened, is best accomplished by an incision along the right side of the ascending colon, thus mobilizing the caecum.
A RETRORECTUS LAPAROTOMY INCISION AND CLOSURE.

BY JOHN J. MOORHEAD, M.D.,
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In gaining access to the lower abdominal cavity numerous incisions have been planned with the dual object of attaining: (1) Requisite exposure with a minimum of structural damage; and (2) protection against subsequent hernia.

The McBurney "gridiron" or muscle-split incision deservedly holds a prominent place in this type of procedure; but because this had a limited application, entrance has been sought through the split fibres of the rectus muscle (Deaver incision), or at the outer margin of the muscle (Battle-Jalaguier-Kammerer incision).

At the present time it is a growing custom to perform median oftener than lateral laparotomy, because experience has shown that multiple rather than suspected single lesions often exist. This is notably true of appendicitis where other pathological conditions are often found, such as membranous pericolicitis, kinks, mobile cæcum, ureteral, tubal and ovarian lesions.

It is my observation that laparotomies are more than ever in a real sense "exploratory," and for that reason lateral incisions are being much more limited and will probably soon be reserved for appendicitis in children or where abscess is apparent.

The transrectus incision (Deaver) is sometimes unsatisfactory because the muscle is often torn or bruised; and also because the deep epigastric vessels are so commonly cut necessitating delay at a stage when it is especially aggravating.

Lateral and retrorectus incisions are theoretically faulty in that the nerve supply to the rectus is in part cut, thus predisposing to hernia; however, the adequacy of exposure and the possibility of interposing the entire intact muscle between the
Skin retracted outward and line of incision as for appendicitis.
Line of incision in anterior rectus sheath.

Outer portion of sheath dissected outward to the shelving edge.
Line of incision in posterior sheath and peritoneum.
Posterior sheath and peritoneum united.
Outer edge of intact rectus united to shelving edge of anterior sheath.

Anterior sheath and part of skin united; approximate planes of incisions shown.
Retrorectus laparotomy incision.

Incisional planes to a great extent modifies this technical objection.

During the past two years the retrorectus incision and closure to be described have been used in practically all low laparotomies by the writer, and a description of it is offered because it appears to provide an easy and adequate approach with little traumatism, and to a great extent should protect against subsequent hernia. In addition to the stairway planes of the incisions, a method of closure of the second layer is also presented, this resembling a similar step in inguinal herniotomy (Bassini).

Technic.—The abdominal wall is rendered tense by pulling the skin toward the anterior iliac spine. A vertical incision is made of the desired length (usually three inches), two and a half or three inches from the median line, and it is deepened until the anterior rectus sheath is seen (Fig. 1).

The taut skin is then allowed to fall into place.

The anterior rectus sheath is nicked at a point one-half inch or more internal to the line of the skin incision and it is then incised to the length of the skin wound. This incisure is at least one-half inch within the linea semilunaris (Fig. 2).

The outer portion of the anterior rectus sheath is then dissected bluntly from the muscle until the attachment to the linea semilunaris appears, and here the junction will be found to resemble the “shelving edge” of the external oblique fascia at Poupart’s ligament. The intact rectus muscle is thus exposed at the outer margin. The remaining inner portion of the anterior rectus sheath is undisturbed (Fig. 3).

The entire intact muscle is now retracted toward the median line and this often brings the deep epigastric vessels into view; they should not be damaged, but when caused to bleed immediate ligation is made (Fig. 3).

The posterior rectus sheath, areolar tissue, fascia and peritoneum, as one layer, are incised as nearly behind the middle of the rectus muscle as retraction and the needs of the operation permit (Fig. 4).

Closure.—Peritoneum-fascia is united by a continuous catgut suture (Fig. 5). The outer edge of the rectus muscle
is united by continuous catgut sutures to the exposed shelving edge of the under surface of the anterior rectus sheath, previously dissected to the semilunaris (Fig. 6).

The anterior rectus sheath is joined by a continuous catgut stitch (Fig. 7). The skin is united by catgut, linen, silk or favorite material (Fig. 7). If desired, one continuous suture may be used for several or all layers.

Where drainage is required, a suprapubic or supraginginal opening is provided.

It will be seen that the incisions divide practically three structural layers; namely, skin, anterior rectus sheath, and fascia-peritoneum, the intact muscle intervening.

The closure is in four layers, and the important anterior rectus sheath is doubly united.

The planes of incision are respectively two and one-half (skin), two (anterior rectus sheath), and one and one-half inches (fascia-peritoneum) from the median line; this proportion obviously may vary slightly within narrow limits.

This technic is presented not so much with the idea of being novel, but because it appears satisfactory for the following reasons:

1. Adequate and rapid exposure without undue traumatism to intervening layers or vessels.
2. Prolongation of the original incisional lines is readily accomplished when needed.
3. The rectus muscle and its blood supply are undamaged and very little bleeding occurs.
4. Closure in four non-superimposed layers adequately guards against hernia, notably because of the interposed intact rectus and the plication of it to the shelving edge of the anterior sheath.
5. The double line of suturing in the anterior rectus sheath should to some degree compensate for the apparent damage inflicted upon the nerve supply, a vice inherent to all similar vertical incisions.

The same principle and "stairway" type of incision may be followed by pulling the skin toward the median line instead of away from it.
THE ANATOMY OF A CASE OF CARCINOMA RECTI.

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In many instances practical anatomical studies in relation to clinical work have been and are being made by clinical men, anatomists as a rule confining themselves to the morphological aspect of their science. While this is quite a natural state of affairs it seems unfortunate that such a profusion of material as must present itself in the dissecting room of any large medical school, should remain unutilized. The case of carcinoma recti which is described in the present communication was found in the dissecting room of this school during the past winter session and stimulated the observations here put forward. It was my privilege to be assistant to Professor J. W. Smith, of Manchester, Eng., at many operations for resection of the rectum by his perineal method. The principles on which this operation is based have been published elsewhere, 1, 2. These principles were formed as a result of our dissections of the normal cadaver in addition to the large operative experience of Mr. Smith. Having now had the opportunity of dissecting a typical case of carcinoma recti it is possible to discuss the anatomical facts which must be considered in relation to the diseased organ. It is to be understood that present comments refer more particularly to carcinoma occurring in the ampulla of the rectum or in the region of the great third valve of Houston as indicated in Fig. 1. This portion of the organ is better termed the perineal chamber.

The problems of greatest importance in connection with resection of this portion of the gut, and which, at the same time are capable of illumination from the anatomical standpoint may be stated briefly as:

1. The directions of permeation of the cancer cells.
2. The vascular supply of the gut subsequent to operation.
3. The manner in which the rectum is normally held in situ.

It is generally accepted that lymphatic extension occurs late in this disease except in the pararectal glands (anorectal glands of Gerota), in the immediate efferent trunks which follow the course of the hemorrhoidal vessels, and in those lymphatic channels which eventually open into the inguinal group of glands. The present case bears out the above view. As may be seen from Fig. 1, the original growth occurs in the perineal chamber and in addition a large fistulous ulcer with undermined walls and sloughy base lies on the left side of the anal canal. Fig. 2 illustrates the condition of the inguinal glands. The pararectal glands are numerous and large but all enlarged glands are on the inner surface of the so-called pelvic fascia. None are to be found between the pelvic fascia and the sacrum. No infected glands are found above the sacral promontory and the liver shows no metastasis in spite of the advanced stage of disease.

A considerable portion of the tumor occupies the anterior wall of the ampulla and is fixed to the prostate. There is, however, no involvement of the latter organ. The posterior portion of the sheath of the prostate is thickened and consists of very dense fibrous tissue. But it was a simple matter to free the prostate from the infected area.

As the lymphatic tracts along which the carcinoma may permeate, with the exception of those along the superior hemorrhoidal vessels, leave the lower portion of the perineal chamber and progress along middle and inferior hemorrhoidal vessels and also toward the inguinal glands, it is obvious that the possibility of widespread growth is more likely if the primary tumor is situated low down than when it is in the region of the great valve of Houston.

The fact that all enlarged glands in the pelvis were found between the rectum and the layer of visceral pelvic fascia lying between rectum and sacrum, is important. For during operation, if resection of rectum and this fascia be done in one piece, all the involved glands will be effectually extirpated without surgically soiling the remaining tissues of the pelvis. The
Carcinoma recti in patient aged sixty-two. Left face of mesial anteroposterior section of pelvis. The clinical notes and diagnosis received give no information respecting the condition. a, site of carcinoma in rectum; b, pouch of Douglas; c, bladder; d, seminal vesicle; e, prostate; f, bulb of urethra; g, fistulous ulcer; h, levator ani; i, rectosacral aponeurosis; j, carcinomatous pararectal gland. It is to be noted that though the infected gland shown in the figure lies just above the levator ani, it is separated from the latter by the rectosacral aponeurosis. This fascial sheath for the rectum and pararectal glands is very well marked in the specimen from which the drawing was made and shows clearly its attachment to the sacrum. The only successful manner of taking out rectum and pararectal glands in one piece is to dissect from below, passing the hand between levator ani and rectosacral aponeurosis and next between the latter and the sacrum. The numerous sacral attachments of the aponeurosis render it impossible to satisfactorily perform this manoeuvre from above. The muscle and aponeurosis lie in immediate relation with each other in the present case, but could easily be separated.
FIG. 2.

Photograph of inguinal region to show the enlarged glands present in association with the carcinoma and fistula.
fascia referred to, may, following Smith's lead, be termed *rectal fascia* or *rectosacral aponeurosis*.

Local extension to the sacrum usually occurs by permeation along the course of the middle hemorrhoidal artery and sacral nerves in the tissue of the rectal stalk, which will be mentioned later. Local extension forward to the prostate or female genital organs is always preceded, as in this case, by preliminary fibrosis, which may lead to the suspicion of involvement by growth. But examination under anesthetic frequently decides this point. In all male cases a sound passed through the urethra is of advantage in fixing anatomical landmarks.

As regards its lymphatic arrangements, the rectum is termed by Smith a "self contained" organ. If it can be excised together with the rectal fascia in one piece, the probability of recurrence is greatly reduced.

In order to successfully perform this operation it is essential to dissect the organ out by the perineal route (see attachment of rectal fascia to rectum (Figs. 1, 3, 4).

The relation of the rectal lymphatic chains to those of the pelvic colon will be mentioned in the next section.

As regards the vascular supply of the rectum the researches of Hartmann and Davis have shown that there is no anastomosis between terminal vessels on the wall of the gut. This is a particular instance of a general principle carried out through the whole length of the intestine, small and large. The usual arrangement of anastomotic channels is diagrammatically shown in Fig. 3 made from a dissection carried out in Manchester. Hartmann's "critical point," the anastomosis between the superior hemorrhoidal and distal sigmoidal arteries, is marked by an asterisk and lies 1 to 1.5 cm. below the sacral promontory and somewhat to the left of the mid-line.

As Davis observes, it is impossible to be sure of ligaturing the superior hemorrhoidal vessel above this point and so maintaining the integrity of the vascular supply of the terminal piece of gut which is sutured to the perineal skin, if the operation is performed by the perineal route. But Riese pointed out that even by the abdominal incision in the combined method of operation it is not feasible to determine the proper point for
safe ligation. Sudeck has even gone so far as to suggest ligation of the inferior mesenteric artery. The occurrence of gangrene subsequent to operation, even after elaborate precautions have been taken to preserve the blood supply, suggests the necessity of some further modification of technic.

The anastomosis between proximal and distal sigmoid arteries is maintained by the vascular loop shown in Fig. 3. If, therefore, part of the distal limb of pelvic colon be removed with the rectum, so as to encroach with certainty upon the area of supply of the sigmoidal arteries, there will be less danger of subsequent gangrene. The plan of excising part of the distal limb of the pelvic colon has further recommendation. It ensures removal of a portion of the mesosigmoid which might possibly be infected by retrograde permeation by cancer cells. It allows removal of any length of bowel from the anus upward to approximately 14 inches, 18 in subjects with a long mesentery to the pelvic colon, and would meet in large measure the requirements of Sampson Handley and of Miles. In the
Left face of anteroposterior mesial section through a normal adult male pelvis. The rectum has been pinned forward to show the attachment of the rectosacral aponeurosis to the sacrum. *a*, rectosacral aponeurosis; *b*, levator ani; *c*, nerve to levator ani.
Photograph of vertical transverse section through the diseased pelvis to show dissection of levator ani and rectosacral aponeurosis on the right side. The white stippled area represents the site of the growth. The peritoneum of the pouch of Douglas is pinned out of the way.  

- a, right terminal branch of superior hemorrhoidal artery, passing along the line of peritoneal reflexion from rectum;  
- b, rectosacral aponeurosis (rectal stalk);  
- c, levator ani.
operation performed by Krogius of Helsingfors this distal portion is left in situ, but in Smith's operation it is removed (see Fig. 3).

The anatomical researches of Homen and Wallgren show that in almost all cases the mesentery of the pelvic colon is long enough to allow some part of the loop to be sutured to the anal skin without tension. Certainly in Mr. Smith's experience the excision of the distal portion of the colon along with the rectum has always been successful. Gangrene has never occurred although, as was to be expected, in certain cases the pelvic colon did not come down into the perineal wound as easily as in others.

The removal of the distal portion of the pelvic colon along with the diseased rectum does not increase the operation mortality, a result contrary to continental experience. Moreover, if this procedure be adopted, there is no risk of recurrence in the anal region, a complication, which as Sampson Handley has pointed out, is liable to occur if less bowel be removed.

The third anatomical consideration is that of the normal support of the rectum. In spite of the knowledge that the uterus is upheld by the perivascular and perineural tissue of the broad ligament, especially by the basal portion surrounding the sacral nerves (known as the ligament of Mackenrodt), it is not generally realized that the rectum is supported in precisely the same manner. The levator ani has but little importance as a rectal support. When perineal excision of the rectum is undertaken, the levatores ani may be severed, but that does not result in the cutting adrift of the gut. One cannot draw it down and out through the wound. Between the levator ani and sacrum posteriorly and the rectum anteriorly is a mass of tissue termed by Smith the rectosacral aponeurosis. It connects the lower part of the perineal chamber of the rectum with the sacrum at the level of the third or fourth piece. On dissection this mass of tissue may be artificially shown as a "layer" (see Figs. 4 and 5). It forms one of the layers of visceral pelvic fascia and is less dense in the middle line where it is only feebly attached to the hollow of the sacrum. Laterally, however, it is very strong and consists of
the rectal stalk of Elliot Smith\textsuperscript{12, 13}, that is, the connective tissue surrounding the middle hemorrhoidal artery and the branches from the sacral nerves to the rectum. In a lateral direction the aponeurosis can, as a rule, be traced to the second, third and fourth anterior sacral foramina. It is the rectal stalk which supports the rectum and it enters the stationary portion of the organ, that is to say the lower portion of the perineal chamber or ampulla. The site is indicated in Fig. 3.

The rectosacral aponeurosis forms a posterior capsule for the rectum and pararectal glands while its most lateral parts, the rectal stalks, are the true rectal support. When it is severed, the whole rectum and a considerable length of the pelvic colon can be withdrawn through a perineal wound.

In the treatise by Quenu and Hartmann the operator is directed to destroy the cellular tissue between rectum and sacrum, “the sacrorectal fibrous tracts and certain insignificant nervous and vascular branches.”\textsuperscript{14} As these constitute the main support of the organ they cannot in reality be termed insignificant.

It is along the rectal stalk that extension of the growth reaches the sacrum. One further point of interest lies in the fact that severance of the rectal stalks does not interfere with those branches of the nervi erigentes which come from the same roots but pass onward to the neck of the bladder and the genitals. Normal erections occur in individuals after resection of the rectum when the above-mentioned facts receive attention.

It has been the intention of the writer to recapitulate briefly and in relation to an actual case, the anatomical facts of importance in excision of the rectum. As Harrison Cripps remarks,\textsuperscript{15} the particular route by which a rectal cancer is removed may be of quite secondary importance. “It is a disease in which it is worth while to err on the side of doing too much rather than too little.”

**SUMMARY.**

The points to which attention is drawn in the foregoing pages are the following:
1. The main support of the rectum consists of the rectal stalks of Elliot Smith and not the levatores ani.

2. The length of the mesosigmoid is usually such as to enable the pelvic colon to be brought down and sutured into a perineal wound without danger of subsequent tension or gangrene.

3. The precarious nature of the blood supply of the pelvi-rectal junction, the possibility of retrograde lymphatic extension into the mesentery of the distal portion of the pelvic colon, and of cancerous extension along the gut itself, suggest that free removal of rectum and pelvic colon should be undertaken in cases of cancer of the perineal chamber (ampulla).

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STRANGULATION OF THE UNDESCENDED TESTIS.*

BY CHARLES E. FARR, M.D.,
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The phrase "strangulation of the testis" is rather loosely used to indicate a severe grade of interference with the blood supply of that organ. It may be brought about by torsion, compression, kinking or stretching of the cord. When one considers the exposed position of the testis, its great mobility, and especially the long stalk or pedicle in which its small and tortuous vessels are conveyed, the wonder is that not more cases of strangulation are reported.

The first recorded case is that of Delasiauve in 1840. Nicoladoni, in 1885, reported two cases of his own and several from the literature. Since then the number has increased rapidly and now amounts to about 150 cases. Of these practically one-third were in frankly undescended testes, while a considerable proportion of the remainder gave some evidence of late or maldescent. Many others showed abnormalities of development. In fact most of the authors have considered abnormal descent or development of the testis a necessary condition of strangulation. On the other hand carefully observed cases have been reported in which no such condition was present.

It is well known that the condition of torsion of the cord cannot be produced in the normal human cadaver, although it has been and is frequently done to stallions to produce atrophy of the testis, and sterility. The probability then is that no one anatomical defect can be called the necessary predisposing cause to strangulation.

True strangulation by constriction at the ring, as in strangulated hernia, is hardly conceivable, although a few

* Read before the Surgical Section of the New York Academy of Medicine, April 5, 1912.
cases have been reported of compression of the kinked or looped cord between the body of the testis and the pillars of the ring. A few more are recorded in which the circulation was shut off by excessive stretching of the cord, e.g., when the inguinal testis is forced out of the external ring.

The great majority of cases, however, are strangulated by torsion, either of the testis on the epididymis, the epididymis on its own axis, or, by far the most often, the testis and epididymis upon the cord. This later condition may occur within the tunica vaginalis, or, very rarely, without it, in which case the tunic and testis are both strangulated.

In this paper no attempt will be made to consider those cases in which a strangulated hernia was present, nor the cases presenting fully descended testes. Cases of inflammation without proof of strangulation, and unoperated mild cases, with doubtful symptoms of torsion, will also be excluded. There are probably many such, which, recurring repeatedly and treated as orchitis and epididymitis, lead to simple atrophy of the gland.

Strangulation may occur at any age, but is most common during the ten years immediately following puberty. It may affect either testicle. Untreated it leads to aseptic gangrene, abscess, or more commonly, simple atrophy. In animals the gland is completely lost after 22 hours of strangulation, while in man 75 per cent. of the cases have had to be castrated, and of the remainder, nearly all sloughed or atrophied. It must be remembered, moreover, that, in the case of the undescended testis, one is dealing with a gland which is frequently abnormal and has already undergone degenerative changes.

In strangulation by torsion, the conditions usually present are (1) a free lying testis, like an ovarian cyst on its pedicle. If the twist is of the testis proper, the true mesorchium, or vascular pedicle of the testis, must be abnormally long. If the testis and epididymis turn upon the cord, the meso-epididymis must be long and covered on each side with reflections from the tunic. More often the testis and epididymis hang free on the cord, like a ball on a string. In this case the mesorchium
is said to be absent, but more properly speaking, it is ab-
normally long.

(2) The relative size and position of the testis and epididy-
mis vary greatly, the latter lying above, below, or even in
front of the testis after the twist is reduced. The two may
be quite separate, with separate portions of the cord leading
to each. The testis may be, and frequently is, flattened and
abnormal in shape and position, as is the epididymis also.

(3) The tunica vaginalis is usually well developed and
capacious, frequently containing fluid and usually communi-
cating with the general peritoneal cavity.

(4) The cord may be abnormally short or long, is usually
well developed but may be flattened out and even divided
into two quite distinct bundles, one containing the vas and its
arteries, the other the spermatic vessels. In some cases no
abnormality was present and there was no apparent anatomi-
cal cause for the torsion.

A history of repeated attacks of pain is not uncommon and
in some cases undoubtedly twists have occurred repeatedly, be-
ing reduced without operation, or, in a few cases, spon-
taneously. The testis in these cases has usually atrophied.

The mechanism of torsion is obscure, each author advanc-
ing a theory to fit his own case. All lay great stress upon
trauma, even though this be of the slightest. Walking, jump-
ing, straining, a slight blow, even the violent contraction of
the cremaster, have been advanced as the immediate cause.
One author believes that the torsion is of slow development
and that symptoms only appear following the last partial turn
which completes the obstruction. If this were true, one would
surely expect to find occasional twists of the cord in the
numerous operative exposures for hernia, etc. Moreover,
adhesions would probably form, and the twist would remain
after the cord and testis are excised, whereas, as a matter of
fact, it nearly always disappears.

In some cases the torsion occurred during sleep, which
presumably, but not necessarily, would exclude trauma. One
might roll, or kick, even in his sleep.
In a rather noticeably large percentage of cases there is a distinct history of increased intra-abdominal pressure immediately preceding the onset of symptoms. This came from crying, straining at stool, lifting heavy weight, athletic exercises, etc. The condition occurs so frequently to everyone that it cannot be denied as a possible factor in these cases. The force may act upon the different elements of the cord as they approach the internal ring, but more probably is exerted through the open funiculus directly upon the testis, or possibly directly through the weak posterior wall of the canal. A coincident contraction of the cremaster very likely pulls upon one part of the cord more than another, thus starting the twist.

It is easy to see how a quarter turn of the testis may be present at any time, as the flattened testis would naturally lie on its side in the confined space of the canal. A very slight force from behind would then suffice to give another quarter turn, and the torsion is begun. The intra-abdominal force not improbably acts like the force of uterine contractions, forcing the testis onward, causing it to extend and to rotate, especially as it passes either of the rings.

With the onset of torsion great congestion ensues, accompanied usually by a serous transudate, more or less sanguineous in character, into the tunica vaginalis. The increasing congestion dilates the veins, changing their length and thus again increasing the tendency to twist around the unchanged arteries and vas. Why does not the cord untwist spontaneously? Perhaps it does at times and this may explain the recurrent attacks of pain, followed by atrophy, in certain cases. In general, however, the cord does not untwist, perhaps because the irregular shape of the testis and epididymis allows rotation in one direction only. In several cases there has been no apparent reason for the maintenance of the twist, which was easily reduced and showed no tendency to recur. In one case, however, a tendency to immediate recurrence was noted.
The number of twists varies from a half to four or more complete turns, averaging less than two. Curiously enough the left testis usually, though not always, tends to turn clockwise, the right anticlockwise. This may possibly be due to the above mentioned pull on the different elements of the cord, or to the natural tendency of the heavier and larger body of the testis to fall downward and outward toward Poupart's ligament, as it comes through the internal ring. Supravaginal torsion must imply simply a very loose connection between the parietal layer of the tunic and the surrounding connective tissue.

It seems fair then to assume that torsion of the undescended testis is largely due to intra-abdominal pressure, acting directly or indirectly upon the cord and testis: an attempt perhaps, on nature's part, at a forced descent, and comparable to the passage of the fetal head through the pelvic outlet.

The symptoms of torsion closely resemble those of strangulated bubonocele, even in some cases to the extent of complete obstipation. Generally, however, the symptoms are less severe, shock is less in evidence, temperature and pulse are only slightly elevated. Vomiting is apt to occur repeatedly, and the pain is exceedingly severe, much more than in strangulated hernia. This, with the testicle missing from the scrotum, should lead one to suspect the condition, but, remembering the frequent coincidence of a hernia with possible incomplete strangulation, one is never quite sure of the diagnosis. Less than one third of the cases have been correctly diagnosed, a few more have been "guessed at," but the great majority have been treated at first for orchitis, epididymitis or strangulated hernia.

The differential diagnosis from orchitis, epididymitis, and even inguinal adenitis, has to be considered but should not be very difficult if the testis is absent from the scrotum. A coincident Richter's hernia can hardly be excluded, however.

The treatment in the undescended cases is obvious: immediate operation offers the only hope of saving the testis and relieving the patient from intense suffering.
Necrosis of testicle from torsion of the cord. (Case I. Peter K.)
The prognosis for the patient is always good: for the
testis is nearly always bad, except in very early or very mild
cases. The testes removed have all shown tremendous passive
congestion, ecchymosis, and subcapsular hemorrhages, with
degeneration of the testicular substance, and varying degrees
of necrosis, and even gangrene. Infection is rarely present.

Through the courtesy of Dr. William A. Downes the
writer was permitted to operate upon and report the follow-
ing case:

Case I.—Peter K., seven months old, of German parentage
and negative family and previous history. Admitted to the
Babies' Hospital September 23, 1911. Right testis only in
scrotum. Present illness began 5½ days ago, child being cross
and fretful, but appetite and bowels were unaffected. Was rest-
less and cried a great deal. Two days ago child appeared to
have colic and a purge was given. A few hours later a swelling
was noticed in the left groin, which gradually increased in size
and soon became red and very tender. Vomiting occurred 3
days ago, again yesterday and two or three times to-day. Seems
to be in constant pain and keeps his legs drawn up.

Physical examination was negative except as to slight abdomi-
 nal tenderness and the presence of a red, tender mass in the left
groin, apparently in the inguinal canal and running from the
external to the internal rings. No impulse on crying. Dull to
percussion. Rectal examination failed to reveal any distended
loop of gut leading to the internal ring, which could be readily
palpated.

Temperature 102°, pulse 134, respiration 40, leucocytes 19,500,
polymorphonuclears 49 per cent., eosinophiles 3, others 49
per cent.

The diagnosis was in doubt until the absence of the left
testis was noted, under anaesthesia, when the probability of a
strangulated inguinal testis became apparent. Through the usual
oblique incision the inguinal canal was exposed, all the tissues
being found oedematous. Within the canal a rather thick-
walled, bluish sac was found, adherent to the surrounding
structures. This, on opening, yielded about half an ounce of
blood-tinged serum, and exposed a blue-black irregular mass,
the size of a small olive, and attached to a twisted pedicle which ran to and entered the internal ring. The testis was found to be twisted on the cord one and one-half full turns toward the right, that is in a clockwise direction, and, as it appeared gangrenous, it was excised along with the cord. No adhesions were noted. Part of the sac was excised and the aponeurosis and skin closed. No evidence of hernia was seen.

Recovery was uneventful, barring a slight stitch abscess, and the child left the hospital healed on October 10, 1911. When seen six months later, the wound was soundly healed with no evidence of hernia.

The testis and epididymis were enlarged, deeply congested, and showed on section severe interstitial hemorrhages, and only atrophic testicular substance. "Complete necrosis of an atrophic testis" (Prof. Ewing).

Case II.—Operated upon by Dr. Frank Hartley and reported through his courtesy.

Philip C., one year old. New York Hospital. Admitted November 17, 1905. Family and previous history negative. Position of testis not noted by parents. Present trouble began 4 days ago with pain, and repeated vomiting. Child appeared sick, bowels moved to cathartic and improvement took place for 2 days. To-day child seemed in pain and cried on moving its right leg, which was kept flexed. Slight fever. Doctor noted swelling in right groin and diagnosed strangulated hernia.

Physical examination negative except as to a swelling in the right groin size of a small egg, hard, tender, irreducible. No impulse. Right testis not felt in scrotum.

Temperature 101°, pulse 128, respiration 26, leucocytes 25,600, polymorphonuclears 72 per cent. Diagnosis, strangulated right inguinal hernia.

Operation (by Dr. Hartley).—Inguinal canal opened, swollen tunica vaginalis incised and a considerably enlarged testis and epididymis, dark bluish-red in color, exposed. Strangulation due to a twist of testis and epididymis on cord, direction not noted. Mass excised along with the adherent tunica vaginalis. No hernia noted. Sutured and healed per primam. Slight fever, but ultimate complete recovery.

Examination of Specimen.—An irregular mass 2.5 x 1.5 x 1
cm. with indistinct epididymis, and a membranous pouch. Very hemorrhagic testis and epididymis. Sections showed diffuse hemorrhagic infiltration of loose cellular tissue and the tubules of a rudimentary testis.

**Case III.**—Operated by Dr. Frank Mathews, and reported through his courtesy.

Philip K., five years old. St. Mary’s Hospital for Children. October 2, 1911. Family and previous history negative except that mother and boy have pronounced Madelung’s deformity of the forearms, i.e., great relative shortening of the radius and of the whole forearm as compared to the upper arm.

Present illness began yesterday, pain in right groin, vomiting. Pain became severe and child refused to walk.

*Physical Examination.*—Negative except for the right groin where a mass the size of a pigeon’s egg could be seen and felt just above the pubic spine. Very tender. Right testis not down. Left in scrotum.

*Operation* (by Dr. Mathews).—Twenty-four hours from onset. Inguinal canal exposed and dark blue mass found protruding from external ring. Proved to be testis; cord very taut but no torsion. Small empty hernial sac dissected from cord and ligated and removed. Cord loosened up and testis, which had regained its color, pushed into scrotum. Conjoined tendon united to Poupart’s, and external oblique and skin sutured without transplanting cord.

Wound healed promptly except for a stitch abscess, and the child left the hospital on October 25, the wound solid and the testis in fair position at the upper scrotal margin. This appeared to be a case of strangulation by forcible stretching of the cord in a sudden effort to cause descent of the testis.

Table I contains all the cases of strangulated undescended testes in the available literature. Table II gives those of late descent. References are added to all the reported cases of strangulated testes, many of which probably belong in classes I or II, but the data given are inadequate for classification. Table III is compiled from Table I.
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<th>Excited</th>
<th>Cause</th>
<th>Vomiting</th>
<th>Constipation</th>
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<td>Revue méd. franc. et étrangère, 1860, p. 205.</td>
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<td>4 De Quervain</td>
<td>Tribune Medical Press, 1905, p. 214.</td>
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<td>5 Ware, M. W.</td>
<td>Birmingham Med. Rev. 1895, p. 129.</td>
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<td>6 Dippay and Brant-</td>
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</tbody>
</table>

TABLE II.—Cases of Late and Imperfert Descent.

<table>
<thead>
<tr>
<th>Contents of tumour vaginalis</th>
<th>Volume</th>
<th>Contents of tumour vaginalis</th>
<th>Volume</th>
<th>Contents of tumour vaginalis</th>
<th>Volume</th>
<th>Contents of tumour vaginalis</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extravaginal</td>
<td>N o</td>
<td>Bloody serum</td>
<td>O O</td>
<td>Blood</td>
<td>O O</td>
<td>Bloody serum</td>
<td>O O</td>
</tr>
<tr>
<td>None</td>
<td>+</td>
<td>None</td>
<td>+</td>
<td>None</td>
<td>+</td>
<td>None</td>
<td>+</td>
</tr>
<tr>
<td>Labor</td>
<td>+</td>
<td>None</td>
<td>+</td>
<td>Lifting</td>
<td>+</td>
<td>None</td>
<td>+</td>
</tr>
<tr>
<td>None</td>
<td>+</td>
<td>None</td>
<td>+</td>
<td>None</td>
<td>+</td>
<td>Slight fall</td>
<td>+</td>
</tr>
<tr>
<td>None</td>
<td>+</td>
<td>None</td>
<td>+</td>
<td>None</td>
<td>+</td>
<td>Slight fall</td>
<td>+</td>
</tr>
<tr>
<td>Early</td>
<td>+</td>
<td>None</td>
<td>+</td>
<td>None</td>
<td>+</td>
<td>Slight fall</td>
<td>+</td>
</tr>
<tr>
<td>Previous</td>
<td>+</td>
<td>None</td>
<td>+</td>
<td>None</td>
<td>+</td>
<td>Slight fall</td>
<td>+</td>
</tr>
<tr>
<td>Anodic</td>
<td>+</td>
<td>None</td>
<td>+</td>
<td>None</td>
<td>+</td>
<td>Slight fall</td>
<td>+</td>
</tr>
<tr>
<td>Closesc</td>
<td>+</td>
<td>None</td>
<td>+</td>
<td>None</td>
<td>+</td>
<td>Slight fall</td>
<td>+</td>
</tr>
<tr>
<td>Age</td>
<td>15</td>
<td>60</td>
<td>25</td>
<td>50</td>
<td>19</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Number</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>
### TABLE III.

**Age.**

<table>
<thead>
<tr>
<th>Age Range</th>
<th>Cases</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 1 year</td>
<td>4</td>
<td>13–16 years (inclusive), 10, 22 per cent.</td>
</tr>
<tr>
<td>1–5 years (inclusive)</td>
<td>13</td>
<td>17–30 years (inclusive), 12, 27 per cent.</td>
</tr>
<tr>
<td>1–10 years (inclusive)</td>
<td>14</td>
<td>Over 30 years, 5</td>
</tr>
<tr>
<td>1–12 years (inclusive)</td>
<td>16</td>
<td>36 per cent.</td>
</tr>
<tr>
<td>Over 30 years</td>
<td>5</td>
<td>Not mentioned, 2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Direction</th>
<th>Right</th>
<th>Left</th>
<th>Not mentioned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clockwise</td>
<td>4</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>Anticlockwise</td>
<td>7</td>
<td>5</td>
<td>19</td>
</tr>
</tbody>
</table>

1 Total number of cases, 45; youngest, 3½ months; oldest, 41 years.

- Greatest degree of twist, 1260
- Least degree of twist, 180
- Average degree of twist, 480, in 33 cases
- Not mentioned, in 10 cases
- None found, in 2 cases

- Previous attacks, 7 cases
- Diagnosed before operation, 14 times
- Not diagnosed before operation, 19 times
- Proper diagnosis considered, 7 times
- Not mentioned, 5 times

The following case, seen after the preceding observations were written, is of considerable interest from the diagnostic standpoint. C., aged seven years, of negative family and personal history until a year ago, when the parents first noticed that the right testis was not in the scrotum. The boy had been playing "see-saw" and complained of great pain in the right groin, where a small lump was noticed. The pain soon passed away but recurred at intervals during the year past. On the night of admission to St. Mary's Hospital, June 11, 1913, the boy was taken with excruciating pain in the right groin, following excessive climbing. His bowels had not moved during the day but were regular previously. There was no vomiting. A tender lump was felt in the right groin. The boy was brought 30 miles in an automobile and vomited 3 times during the trip. On admission, a very healthy looking boy, no evidence of shock. No distention, temperature 99°, pulse 90. Left testis normal, right scrotal sac empty. In the right groin, at the external ring, an exceedingly tender lump, size of pigeon's egg, slightly movable, giving no
impulse. At the level of the internal ring a slight elevation was noted extending along the canal. Diagnosis, strangulated inguinal testis with possibly a Richter's hernia.

Immediate operation, 7 hours after onset of symptoms. Usual Bassini exposure. The tumor at the external ring was found to be a tightly strangulated loop of ileum, containing hard faeces, and caught by the external ring. This was freed, examined and reduced. The testis was found at the internal ring, atrophic, misshapen, and showing no evidence of torsion or other injury. The Bevan operation was performed and the child made a perfect recovery. This teaches the difficulty of excluding a strangulated hernia in these cases, and the folly of expectant treatment as advised by some writers.

The author wishes to express his appreciation of the courtesy of Doctors Hartley, Downes, Mathews and Ware in allowing the publication of their cases. Doctor Ware also reported several cases of strangulation of descended testis, as did Doctor Moschcowitz, at the meeting of the Surgical Society, at which this paper was read.

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STRANGULATION OF THE UNDESCENDED TESTIS. 851

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SARCOMA OF THE CHEST WALL.

BY J. F. BALDWIN, M.D.,
OF COLUMBUS, OHIO,
Surgeon to Grant Hospital.

The comparative rarity of operations for tumors involving the chest wall is well indicated by the statistical article by Lund, in the ANNALS OF SURGERY, August, 1913, in which he refers to Parham's paper, published in 1898, in which the writer had been able to collect only fifty-two cases of surgical operations in which the pleural cavity had been opened. To these cases Lund is able to add twenty-eight, and he reports one case of his own.

The probability is that there are a good many surgeons who have operated in cases of this kind, but who have never reported their results. I can add to the number three cases of my own, two being cases of primary sarcoma, and one of secondary carcinoma.

Case I.—R. A., aged eight. Physician, Dr. C. U. Hanna, Zanesville, Ohio. Operation, October 20, 1906. Patient had complained of a little soreness in his right side for a number of months, but his complaints were slight, and nothing had been noticed to account for them until a very few days before he had been brought to me. At that time a swelling was noticed by his mother in the right side, and a physician at once consulted. His general health had apparently not been particularly affected by the growth. The growth was found to be low down on the right side, and to apparently involve more than one rib. Everything was quite tender in that region. The outlines of the tumor were not distinct. X-ray examination showed the eleventh rib was the only one involved. At the operation this rib was completely removed, with opening of the pleural cavity. In anticipation of its being opened, a gauze sponge had been promptly applied so that there was only partial collapse of the lung. Hemorrhage was rapidly controlled, and the incision closed without drainage.
No shock. He made a prompt recovery. A letter received from his physician under date of August 16, 1913, states that patient is in perfect health. The diagnosis of osteosarcoma was confirmed by microscopical examination.

CASE II.—Mr. A. P., aged thirty-two. Physician, Dr. L. P. Brumm, Celina, Ohio. Operation October 23, 1912. I had operated upon this patient something more than a year before for chronic appendicitis. Sometime after this he commenced complaining of pain in the back, but nothing could be found by his physicians to account for the trouble. He finally consulted Dr. Brumm, who found a tumor on the right side between the scapula and the spine, and referred the case to me. Examination showed a bony tumor at the point indicated. This was about three inches in diameter, and involved several ribs. A radiograph confirmed the diagnosis, and showed that three ribs were in the growth, but the vertebrae seemed to be free. I advised operation, but giving a very doubtful prognosis as to the ultimate result. In operating it was necessary to remove parts of four ribs. The ribs were cut well forward of the growth, the scapula being pulled to the outside. After removal of the mass it was found that the transverse processes of the vertebrae were involved, and these were accordingly cut away. There was free hemorrhage, which, however, was controlled. The lung had completely collapsed. The pleural cavity was cleaned of blood, and the flap closed without drainage. Very little shock. I had expected to aspirate the air within a few days, but it was rapidly absorbed and the patient left the hospital a little later in excellent condition, healing having taken place by primary intention. Microscopic examination showed osteosarcoma.

Under date of November 27, his physician wrote me that he feared there was beginning trouble, and I advised him to use Coley's serum. Under date of August 18, Dr. Brumm writes that patient did not take the Coley serum, but fell into the hands of quacks, and while still alive is nearly at the end.

CASE III.—Mrs. E. A. A., aged fifty-four. Physician, Dr. T. W. Rankin, Columbus, Ohio. Operation May 18, 1913. I had removed the left breast of this patient for cancer in November, 1909. She had made an excellent operative recovery, but some months before she returned a tumor had developed just to the left of the sternum, and involving some of the cartilages of
the ribs. There were no signs of recurrence anywhere else, and her general health was good. I advised removal of the growth. This was done by an elliptical incision, going well away from the tumor. The cartilages were cut through with strong scissors, opening the pleural cavity quite widely. The opening was kept closed as best my assistants could with gauze sponges, but there was extensive collapse of the lung. Hemorrhage was controlled, and the tissues around undermined so that the opening was entirely covered by skin. Practically no shock. Patient made an excellent operative recovery.
BOOK REVIEWS.


Volumes I and II of this manual were reviewed in the Annals of Surgery for September, 1912. Volume III describes the surgical affections of the joints, head, face and spine (pp. 515). This is a very well-balanced volume and full of practical interest. The better of the newer methods are given due consideration. One notices, however, that the treatment of Pott's disease by the insertion of a bony transplant is not considered—perhaps wisely while the procedure is sub judice. Intracranial surgery is treated very briefly, for instance, no mention is made of the surgery of the pituitary body. Volume IV describes the affections of the jaws, tongue, and floor of the mouth, the pharynx and the oesophagus. The surgical affections of the stomach and intestine, including the rectum, comprise the rest of the book.

This portion of the work equals the high standard reached by the previous volumes and is full of sound doctrine and valuable practical instruction. The section on the large intestine might have been elaborated to advantage in view of the increasing possibilities of treatment, diverticulitis for example. So far as this manual is concerned the resources of the X-ray might be said not to exist, so meagre is the hint of their usefulness. Both volumes are generously illustrated, the diagrams, many of them new, are remarkable for their efficiency in demonstrating essential features.

Charles L. Gibson.

The first two volumes of this work are presented for review. Various commendable features immediately attract attention, among them the general compilation of the work, the noticeable excellent selection of the illustrations and the absence of space consuming, useless and threadbare ones. The detailed descriptions of various technic for the same operation which so soon become obsolete and only of historic value, is not given the valuable space needed and here utilized for the more practical surgical pathology and diagnosis.

Where operative procedure is considered the authors have stated the surgical object to be attained and specified the technic believed by them to be the best. Where radical difference of opinion exists as to the choice of two procedures they have given both with the reasons for their preference.

One hundred and eight pages of modern bacteriology, excellently compiled and presented, occupy the first volume, likewise forty pages are devoted to the pathology of pus producing infections.

The subject of surgical shock receives less attention than it deserves, and no recognition is given the fine work of Crile and Henderson on this subject nor on that of general and local anaesthesia.

Particularly valuable are the thirty pages on radiography with their special attention to the errors of interpretation and technic.

Gastro-intestinal surgery is dealt with in the light of the most modern diagnostic and operative progress and occupies four hundred and thirty-one pages of the second volume. The importance of the relation between various colonic bands and membranes, and chronic intestinal stasis are not given the attention that American experience would dictate.

The chapters on urology at the end of the second volume are surgically very practical and contain much that is of value relative to the prostate and methods of differential diagnosis.

In contrast to other surgical works an extensive bibliography is found at the end of each chapter; this with a particularly
complete and well arranged index and many explanatory footnotes recommend the work as worthy of high commendation.

W. C. Woolsey.

Fibroids of the Uterus: Their Pathology and Treatment.


This little volume presents in a clear and readable manner the main facts regarding the pathology, symptoms, differential diagnosis, and treatment of fibroids of the uterus. The author has a preference for hysterectomy, partial or complete, to more conservative treatment, and gives numerous reasons, such as the difficulty in differential diagnosis in some cases between a fibroid and a sarcoma, even when aided by the microscope; the danger of overlooking a second fibroid when performing enucleation; and the satisfactory results obtained by hysterectomy.

Exception may be taken by some to the general application of certain of the author's dicta, for example, that "Fertility protects against fibroids but predisposes to cancer of the neck of the uterus," that "Dry gauze and dabs are harsh and irritating to the peritoneum and a cause of adhesions," and to his exclusion from the list of necessary instruments and description of the operations of any reference to retractors. Among the more interesting chapters of an instructive book are those on the clinical features of uterine fibroids; the differential diagnosis of fibroids and pregnancy; the relative value of subtotal and total hysterectomy, and the fate and value of belated ovaries.

The work is well got up, of convenient size for the hand, and its value is much enhanced by numerous illustrations.

John A. C. MacEwen.


This book deals with the problems incident to the creation and operation of institutions for the care of the sick, whether public, private, mixed, or special hospitals. An introductory chapter describes the three main classes of hospitals. The authors look
upon the hospital as in a state of evolution, out of which are now
developing certain fixed principles. One important and hopeful
thing, which they recognize is, that the time is shortly coming
when the acceptance of a patient will carry with it an obligation
to furnish every known and approved scientific aid for the diag-
nosis and treatment of disease, irrespective of whether the patient
is a pay patient or a charity patient.

It is evident that the sociology of the hospital problem is get-
ting into line with the modern social trend. It is getting itself set
right with reference to human values and obligations. The dis-
tinctions between taxpayer and poor man are melting away in the
light of the knowledge that every workman is a taxpayer.

This book deals not only with the economics of the hospital,
but with its construction also. The architecture and general plan,
in all their finer details, are so well described, that it will serve
as an authoritative guide in hospital development. The modern
innovations are not wanting. The methods of construction and
maintenance of the operating suite, signalling systems, refrigera-
tion, vacuum cleaning, sun rooms, stool and urine sterilizers,
anæsthetizing apparatus, food cars, and other appurtenances which
have undergone recent changes, are found well described. The
minutie of such parts as window frames, plastering, and furring,
screens, blanket warmers, and the lighting system are not neglected.

The chapter on equipment embraces practically everything
from boiler room to kitchen and from wards to operating room.

The operation of the hospital is discussed in its practical de-
tails. The board of directors, the superintendent, the medical staff,
the nursing staff, operating room supplies, the department of path-
ology, the department of hydrotherapy, dietetics, isolation, the
X-ray department, records, social service and out-patient work,
business management, laundry, bakery, and the destruction of
waste, are some of the subjects elaborated.

The rules for the administration of technical departments
testify to the authors' experience in hospital work. Concerning
the board of directors, it is stated that, "the crying need in
directories of institutions in this country, operated without profit,
is for men and women who will take a personal interest,"—and,
we might add, who possess common sense, tinctured with zeal for
the truth, who are capable of growth, and who make the cure of
the patients the supreme object of their hospital interest. It is
to the everlasting disadvantage of our hospitals that boards of directors are loaded up with men whose chief merit is that they are eminently respectable, that they are the friend of some body of alleged importance, that at some time they performed a service which merits eternal reward, that they may bequeath a bit of their property to the hospital, or that they may bestow upon an eleemosynary institution in their old age the same sagacity which they employed in accumulating a fortune in their youth, and whose function as directors consists in utter indifference to the needs of the institution, or expresses itself in meddlesome activities in some department of its affairs in which they have little aptitude, and to which they give freely of their time, because it is the chief thing they have to expend. It is to be regretted that the author has not specifically advised the appointment of progressive, independent, medical men on the directorate of hospitals.

The chapter on the superintendent is practical and full of suggestions. It might wisely be adopted as a code by the Association of Hospital Superintendents. The first sentence in the chapter on the medical staff is: “The medical staff is the most important factor in any hospital.” This should be accepted as a watchword and guide by every board of managers, for too many accord the supreme place to “our board of managers”; or to “our splendid superintendent”; or to “our beautiful building”; or to “our ministering angels, the nurses”; or to “the popularity of our medical staff.” In reality, these estimations are often correct; but woe betide the patients when anything is more supreme than the competence of the medical staff.

The ethics of internship embraces a discussion of the relation of the house staff to the nurses, in which the author displays rare judgment in dealing with a difficult problem, and shows that he is human as well as astute. The trained nurse and the training school are illuminated by a judicious discussion. The author believes that there is a place for two classes of nurses—the highly trained and the more menial nurse. The problem of the male nurse he regards as discouraging.

The whole spirit of this book is admirable. The authors frankly state that it is based upon their own experience with little reference to the work or opinions of others. The shortcomings, of which they warn the reader, have eluded the vigilance of the reviewer.

JAMES P. WARBASE. 

This book embodies in a formal treatise for the first time in the English language the results of recent endeavors in the investigation and treatment of disorders of the nasal sinuses. It, therefore, takes a place, hitherto unoccupied, of importance and interest; and the author must be accorded the thanks of that considerable number of English speaking rhinologists who do not read other languages with facility, for the collection of a large mass of foreign literature, apart from the actual merits of the book itself.

In the first part of the work—General Considerations—is embodied the anatomical study of the regions treated, which the author for convenience has divided dogmatically into three portions which he calls 1. inferior turbinal portion, 2. middle turbinal portion, and 3. ethmoidal portion. These include the entire outer wall of the interior of the nose and are examined, seriatim, superficially (from within the nose) and the successive structures beneath them (from within outwardly). Thus the turbinates are removed in order to examine the ostiums of the sinuses and contiguous structures, then the sinuses themselves. To facilitate this anatomical study besides numerous text cuts, a frontispiece is arranged with three overlapping sheets of translucent paper each of the latter having printed on it a separate portion of the structures overlying the sinuses, with explanatory marginal text. The structures entering into the formation of the sinuses are then examined piecemeal and collectively. The development of the sinuses from birth is traced. This first part further contains, under separate headings, the physiology of the sinuses, their uses, including the various present and former theories regarding them, the mechanism of their normal drainage, their bacteriology, causes of their diseases, the reasons for chronicity, their pathology, general symptomatology, diagnosis, treatment and complications.

The four subsequent parts of the book treat, respectively, the maxillary, the frontal, the ethmoidal and sphenoidal sinuses. In each of these divisions the author expounds the anatomical rela-
tionship of each, normal and abnormal, their acute and chronic inflammations, the methods of the surgical examination of each, their respective complications, etiology, pathology, prognosis and surgical treatment, detailing the steps of the various operations of well-known authorities.

This work is much more than a mere compilation covering the recent advances in the entire field of the surgery of the nasal accessory sinuses. It is a well planned book in which all pertinent details have been conscientiously presented.

The reviewers feel personally grateful to the author, who has placed in convenient form, and more fully than has heretofore been attempted in English, the diagnosis and treatment of the nasal accessory sinuses. The 247 illustrations, the 5 colored plates and the novel frontispiece, spoken of, are newly made for the book.

WILLIAM C. BRAISLIN.


This book contains a vast fund of information so arranged and presented that it holds the attention of the reader from the first to the last page. The entire field of surgery, including much of the operative work of the orthopaedic surgeon, gynaecologist, otologist and laryngologist, is covered. Ophthalmology alone is omitted. There is no unnecessary discussion of unsettled points. The facts of surgery are clearly and concisely stated in the way best calculated to impress them upon the reader, and every page bears the personal imprint of the practical surgeon and teacher. Nearly all the latest advances in surgery have been incorporated in this edition, but the statement on page 468, "All attempts thus far to resect a portion of the thoracic gullet have been fatal," is no longer true, for Torek has reported a successful case since the book went to press.

The section on Surgical Technic is especially good. It is evident that the author has drawn chiefly upon his own experience, and for this reason it has additional value. The older method
of preparation is favored rather than the present more popular iodine one.

Most surgeons will take exception to the statement that "Always at the close of an operation it is desirable to flush the wound with hot sterile water or salt solution," especially when this procedure is advised later on for chronic brain abscess, wounds of the spine, chronic empyema, peritonitis, appendiceal abscess, etc.

The chapter upon the abdomen is the best in the entire book. Gastric and duodenal ulcers are considered in a simple, plain and thoroughly up-to-date way. The present views of most surgeons are embodied in this section, which is neither too conservative nor too radical in its advice. The necessary operations are well described and illustrated by excellent colored cuts. Compression of the duodenum by the mesentery of the small intestines, membranous pericolitis, diverticulitis, and Lane's kink all receive appropriate attention. No surgical condition of importance seems to be omitted.

The index is extensive and complete. This book can be highly recommended to those for whom it is intended—the student and general practitioner—and many a mature surgeon could profitably spend a few hours in its perusal.

It would be very difficult to find another single volume of this size that so thoroughly covers the field of surgery and in which so little could be found to criticise, and so much to praise.

HENRY FLACK GRAHAM.
CORRESPONDENCE.

CONTRACTURE OF PSOAS MUSCLE SIMULATING APPENDICITIS.

EDITOR OF THE ANNALS OF SURGERY:

After reading the paper by Dr. George E. White on "Contracture of the Psoas Parvus Muscle Simulating Appendicitis," in the ANNALS OF SURGERY for October, 1913, I wish to place on record a similar case, which was operated upon by me in 1904.

Mrs. B. H., age twenty-five, complained of constant pain over McBurney's point, also some pain and tenderness in the lumbar region of the right side. The diagnosis was finally made of chronic appendicitis and patient was operated upon in 1904. The appendix appeared to be practically normal, but underlying the appendix was a rather tense, whitish, contracted band, which was observed at the time and commented upon. Nothing was done with this, however, at the time.

The patient received practically no benefit from the operation, the pain continuing for several years. No secondary operation was done, but the cause of the continued pain was attributed to the contracted psoas muscle, the cause of which was unknown. No evidences of general or local tubercular trouble.

JAMES L. STEWART,
Boise, Idaho.

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Remittances for Subscriptions and Advertising and all business communications should be addressed to the

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227-231 South Sixth Street,
Philadelphia.
ANÆSTHESIA SUPPLEMENT

ANNALS OF SURGERY

DECEMBER, 1913
IMMEDIATELY following a symposium on anaesthesia, held under the auspices of the Sections on Physiology and Pathology of the American Medical Association, at the meeting at Atlantic City, June 12, 1912, the American Association of Anaesthetists was organized.

The prime object of the organization, as expressed in its constitution and by-laws, is to advance, in every way possible, the science and art of anaesthesia.

In order to accomplish this it is the purpose of the Association to stimulate experimental and clinical investigations by endeavoring to bring together, at its annual meetings, representatives of the allied branches of science—surgeons, physiologists, chemists and pharmacists, as well as anaesthetists—for conference and comparison of data with reference to special phases of the subject which they are actively engaged in developing.

Such annual inventories of achievement serve the double purpose of stimulating effort in predetermined lines, and of clearly revealing lines toward which investigation should be directed. The truth of this may be realized and the possibilities of correlated effort may be understood when it is brought to

* Read at the first annual meeting of the American Association of Anaesthetists, Minneapolis, Minn., June 18, 1913.
mind that more real progress has been made in the study of anaesthetics and anaesthesia during the last ten years than during the rest of the sixty-five years which have elapsed since the first public demonstration of anaesthesia was made.

For many years little attention was paid to the administration of anesthetic agents in combinations and sequences, chloroform, ether, nitrous oxide, the three anaesthetics employed, being used alone each in its respective field. The earlier administrators, therefore, failed to utilize underlying principles which are conducive to increased efficiency and to a modification of unpleasant effects in the induction period, during the course of the anaesthesia, and during the time of recovery.

This state of affairs is probably accounted for by the fact that anaesthesia has always been considered as a part of surgery and consequently has been under the direct supervision of the surgeon, generally administered by nurse or other untrained assistant. There has consequently developed a tendency to employ some one method, notably the drop method of ether, in practically all cases, thus suiting the patient to the anaesthetic rather than the anaesthetic to the patient. This error is not uncommonly committed, we might say, on a wholesale scale, in certain localities and in certain institutions to-day. This is abundantly proved by the American statistics, recently compiled by the Committee on Anæsthesia of the American Medical Association. These figures show that more than half of nearly half a million administrations, from 1905 to 1912 inclusive, were given by the drop method of ether. The mortality record of this method, as compared with sequences and combinations selected to suit the individual case, is relatively high. In 294,653 administrations of ether by the drop method there were 65 deaths, giving a ratio of 1 death in 4,533 cases. This does not compare favorably with the chloroform-ether sequence of 1 death in 10,007, or the nitrous oxide-ether sequence of 1 in 6,424.

The fallacy of the position assumed by many surgeons, of having nurses instead of physicians administer anaesthetics, is two-fold: In the first place, skilled anaesthetists, know from
laboratory experimentation and clinical experience, that ether alone, by the drop method, is less safe than when it is used in sequence or combination with other agents, and administered by other methods. This applies to safety to life, to muscular relaxation for surgical purposes, and to after-effects. In the second place, it is now generally conceded that the anæsthetic should be selected with respect to the individual case. In order to accomplish this, combinations and sequences must be employed. It goes without saying that this is impossible for the administrator who is untrained in the giving of anæsthetics in general, and who is ignorant of the physiological action of the agent or agents employed.

The position assumed by many with reference to anæsthesia is, therefore, wrong in principle. It is out of harmony with the trend of development of modern medical science. It is certainly not in keeping with the spirit and purposes of the Association of American Medical Colleges, of the American Medical Association, and of the Carnegie Foundation, all of which organizations have aimed at the elevation of the standard of requirements of medical colleges, and at raising the general tone of the medical profession. There is no more reason why a nurse, an undergraduate medical student, or an untrained hospital interne, should be entrusted with the life of the patient, as is the case in the giving of an anæsthetic, than that such individual should be allowed to perform a surgical operation which endangers the life of the patient, or to treat a disease the successful culmination of which entails the ability to meet exigencies as they arise.

What has been said with reference to nurses, undergraduate medical students and untrained hospital internes, applies equally to dentists. Babcock has recently reported a death under nitrous oxide and oxygen, administered for surgical purposes by a dentist. Dentists are in the habit of giving nitrous oxide, generally to the point of asphyxiation, for short dental operations, but they should not, unless specially trained, attempt to use this agent, and certainly not others, for more extended surgical procedures.
The element of lack of training in the administration is not the only consideration. It is a well-known fact that nurses sometimes become extremely expert in the administration of a particular agent by a particular method, especially ether by the drop method. So skilful have they become in some instances that it is even claimed that, correctly given, this answers the purpose for all surgical procedures. So long as the cases are suited to this particular method all goes well. The anaesthesia is generally very light, and in abdominal work, where muscular relaxation is required, a very free incision compensates for the lack of depth of anaesthesia.

This, like all other methods, has its limitations, however, and when these are reached the administrator, the surgeon, and the patient are face to face with a situation which may prove detrimental to the welfare of the patient, even, sometimes, to the extent of causing death. No better illustration of the evolution of this wrong principle could be cited than the following: A young surgeon called in a nurse, unqualified with respect to anaesthesia, to narcotize for a short, and as far as life was concerned, an unnecessary operation, when doctors were easily available for the purpose. The patient died in less than ten minutes. The result was a court procedure, and the necessary removal of the doctor to another locality. The point involved is that a healthy subject, twenty-one years of age, about to undergo a very minor surgical operation, which of itself exerted no influence upon the course of the anaesthesia, could have been narcotized without difficulty by an anaesthetist of even a fair degree of skill. The physician in this case gave as his main defence the fact that some of the most prominent surgeons of the day employ nurses exclusively for the administration of anaesthetics.

It should be, and is, the purpose of the American Association of Anaesthetists to combat this state of affairs, and to demonstrate, by fact and figure, by experiment and practice, that it is the inalienable right of the patient who entrusts his or her life to a surgeon to have that life safeguarded in every
way possible. The anæsthetist, even more than the surgeon, holds the thread of life in his hands. He should have at his command every facility known to modern science whereby to carry the patient easily into and safely out of the state which has been called “that borderland in which life in many respects so simulates death.”

What facilities for the preservation of health, comfort and life, does the present-day anæsthetist command that were unknown to the physician-anæsthetist of old and to the nurse administrator of to-day?

We have already seen that the utilization of combinations and sequences was practically unknown until within recent years. This is one of the facts which renders the modern anæsthetist equal to almost any emergency, and which has helped so materially in the reduction of the mortality statistics as applied to anæsthesia.

Ether, which was formerly given almost exclusively alone, and very largely by the open or drop method, has been materially increased in value by preceding its administration with chloroform or nitrous oxide.

Chloroform, which has played so stormy a part in the drama of anæsthesia, was formerly used alone. It is now conceded that it should never be used alone, or as the terminal anæsthetic, unless especially indicated. It is a safe initiatory anesthetic to ether when, as preliminary medication, morphine has been administered, the immediate administration being preceded by the inhalation of a few drops of the oil of bitter orange peel.

Nitrous oxide, which was formerly used alone, to the extent of asphyxiation and only in short operations, is now combined with oxygen whenever possible, rendering it safer and making its prolonged administration practical. The combination of nitrous oxide with oxygen, with preliminary small physiological doses of morphine, and a few drops of ether when necessary, is applicable to over 90 per cent. of all surgical cases. Heating the gases by rebreathing or some other method, and the perfection of the apparatus for its administration, are
factors which render nitrous oxide and oxygen applicable in a much larger number of cases than was possible by the older methods.

The definite utility of preliminary medication and adjuvant treatment during the administration have materially increased the safety of all anaesthetics and lessened the danger of unpleasant after-effects. Morphine, particularly, may now be counted among the definite facilities by the judicious use of which the skilled anaesthetist can be fairly sure of a safe and satisfactory administration in practically every case. With local and spinal analgesia, intravenous anaesthesia and general inhalation anaesthesia, it is of distinct value. With nitrous oxide and oxygen it materially assists in abolishing reflex phenomena; with ether, chloroform and ethyl chloride it allays psychic and nervous impulses. It should be used unless contra-indicated.

The unpleasant after-effects of inhalation anaesthetics are materially modified by hypodermoclysis, begun with the anaesthetic and continued throughout the operation. Saline solution introduced in this manner maintains the blood-pressure and this assists in preventing shock either from the anaesthetic or the surgical procedure. When hypodermoclysis interferes with the surgical technic an enema of one or two quarts of tap water (which, according to Trout, is preferable to normal saline), with one or two ounces of glucose added, ten to fifteen minutes before the close of the operation, restores the glycogenic function of the liver, fills out the veins, dilutes any anaesthetic which may remain in the blood, and assists in bringing the patient out of the anaesthetic in the best possible condition.

In addition to the foregoing details of technic which give to the anaesthetist employing them unequivocal advantages over the one who is restricted to the use of a given method which must be employed in all cases, certain factors may be brought into play to modify the physiology of anaesthesia as ordinarily induced. Practically every phenomenon varies with the particular anaesthetic agent administered, with the general condition
of the patient, with the condition of the blood, and with other variable factors which the anæsthetist should be able to recognize whenever they exist.

Chief among these modifying factors may be mentioned certain ones which represent the most recent and most advanced work of the study of the problems involved in the administration of inhalation anaesthetics: 1, warming the agent; 2, utilizing moisture; 3, combining oxygen with the agent; 4, utilizing carbon dioxide; 5, rebreathing; 6, preceding the administration with the oil of bitter orange peel.

1. Warming the Agent.—Since 1905 systematic laboratory experiments and clinical observations have been made to determine the value of the various inhalation anaesthetics, when they are administered cold and when they are warmed to the temperature of the blood. These observations have been made chiefly with reference to: a, safety as regards life; b, maintenance of body temperature and the consequent lessening of the danger of shock; c, recovery from the anesthetic; d, after-effects.

From the animal experiments with the different anaesthetics, i.e., chloroform, ether and nitrous oxide and oxygen, first at room temperature and then heated to the temperature of the blood, and finally with nitrous oxide and oxygen at 33 to 34° F., it may be concluded that all anaesthetics heated to the temperature of the blood are increased in value as regards life without decreasing their anaesthetic effects.

It has been found by careful experiments and clinical observations, that, whatever may be the cause of the loss of body temperature during anaesthesia, *every fraction of a degree of elevation of temperature* of the anaesthetic agent above that of the room will have a marked effect in maintaining the body temperature of the patient.

Recovery from the anaesthetic is facilitated by the natural inhalation of warmed atmospheric air or of the artificial introduction into the lungs of a current of warmed air. Experimental and clinical observations have abundantly verified these findings with reference to the use of warmed anaesthetics.
Both the immediate and the delayed after-effects of inhalation anaesthesia are reduced to a minimum when the agent is administered warm.

2. Utilizing Moisture.—Since 1909 it has been my practice to employ warmed moist vapors of pulmonary anaesthetics. Baskerville has called attention to the importance of moisture. "It has been shown" he says, "that the administration of moist ether, free from aldehyde, at body temperature, is rarely followed by nausea (less than ten per cent.) and the usual strain upon the kidneys is not observed."

It is to be borne in mind that too high a vapor-saturation acts as deleteriously as too much dryness.

3. Combining Oxygen with the Agent.—Carefully conducted experiments and clinical observations have abundantly proved that oxygen increases the value of all anaesthetics in rendering them safer to the patient without decreasing the anaesthetic quality.

4. Utilizing Carbon Dioxide.—Extensive physiological experiments have established the fact that carbon dioxide is not merely a waste product but performs a distinct rôle as a chemical regulator of various functions. The reduction of carbon dioxide leading to apnoea can be effected by various means detailed by Henderson, as follows: 1, artificial respiration; 2, the hyperpnoea incident to the stage of excitement or of incomplete anaesthesia; 3, the hyperpnoea produced by vigorous stimulation of the efferent nerves; 4, exposure of the abdominal viscera to the air so as to allow a free exhalation of carbon dioxide from the surface of these organs.

Regulation of the carbon dioxide contents of the blood under these conditions appears to Henderson to be the most important factor in the prevention of shock.

Shock experimentally induced was rapidly recovered from when a condition which permitted the tissues and blood to restore their carbon dioxide contents was maintained.

5. Rebreathing.—This factor was utilized for many years by professional anaesthetists before being placed upon a firm scientific basis by the laboratory work of Henderson, showing
the necessity of retaining the carbon dioxide in the blood, and the research clinical work of Gatch, establishing the fact that no poisonous element existed in the exhalation of the patient and that the agent moistened and warmed by rebreathing was increased in anaesthetic value as evidenced by the fact that the patient was returned to bed after operation with no loss of temperature and no bad after-effects.

Clinically, rebreathing seems to increase the value of all anaesthetics.

Chloroform—when administered with the Roth Drager apparatus—utilizes rebreathing automatically, and the patient's return to consciousness is as quick and as complete as with nitrous oxide and oxygen.

6. Preceding the Administration with Oil of Bitter Orange Peel.—A fact which exerts a striking influence upon the course of anaesthesia is the preliminary administration, by inhalation, of oil of orange (25 per cent. oil of bitter orange peel, U. S. P., with 75 per cent. of alcohol, U. S. P.).

I had long been in the habit of preceding the anaesthesia by the administration of a one per cent. vapor of cologne or whiskey, the agent being placed on the mask.¹ Later oil of bergamont or terpineol for the purpose of masking the odor of ether vapor was used.²

Finding the induction period of anaesthesia thus deprived of its terrors for many patients, particularly for nervous women and frightened children, the subject lapsing quietly into unconsciousness when the anaesthetic vapor is turned on, a search was instituted for a substance with a more penetrating yet none the less agreeable odor, which could be vaporized and utilized as a preliminary to ether or other inhalation anaesthetic agent.

The search was practically ended when I read of the ex-

²Gwathmey: Terpineol (lilacine) serves to mask the odor of ether vapor and is a respiratory antiseptic, but, like oil of sweet orange, is less satisfactory than oil of bitter orange peel because of its very sweet odor.
periments of Passy, quoted by Tigerstedt, showing that the odor of the essence of orange is ten times as penetrating as that of ether vapor. There are other things that rank ahead of the oil of orange.

To these, however, some patients might find objection, whereas, to the delightful odor of the oil of bitter orange peel, it is hardly likely that any one would object.

These observations have been fully verified in thousands of cases in actual practice. When the open method is used, two to four drops of a 25 per cent. solution upon the mask is sufficient. If half a drachm or more is placed upon the mask at one time as has been done by some experimenters, the powerful odor becomes stifling and the stage of excitement is increased rather than modified.

Woolsey, of Brooklyn, developed and perfected the method of employing the oil of orange-ether sequence by the closed method. He has an individual record of over 500 cases. The author and others have used it in as many more. The latest modification is to mix just a little nitrous oxide with the orange odor. It is used wherever the nitrous oxide-ether sequence is indicated but it is to be preferred to this sequence on account of its safety. The patient goes under in practically the same way as with a good nitrous oxide-ether sequence, but with this notable exception—there is no cyanosis at any time. The second stage, so-called, with struggling, etc., is entirely absent.

The pulse is normal, the color reflex good and there is no disturbing mucous râle.

As orange-ether sequence is of comparatively recent development, its physiological basis may not be uninteresting.

The physiological basis for the beneficial effect of the oil of orange in the administration of inhalation anaesthetics may be found in its prevention of reflex stimulation, by the anaesthetic agent, of certain sensory nerves. Dastre* attributed early syncope to reflex stimulation of the pneumogastric and trigeminal nerves, particularly the sensory branches supplying

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the nasal mucous membrane and the larynx. Embley has also emphasized the part played by the increased excitability of the vagus mechanism, particularly during the early part of the administration. In his inhalation experiments Embley found that failure of respiration is mainly due to fall in blood-pressure. With good blood-pressure failure of respiration (his experiments concerned chloroform) is practically impossible. Restoration of respiration is dependent upon restoration of blood-pressure. The chances of dangerous vagus inhibition are greatly increased by imperfect respiration.

From these findings it would seem fair to assume that any factor which prevents undue inhibition of the nervous mechanism of respiration, and which, by its stimulation of the respiratory centre, prevents fall in blood-pressure, will have a beneficial influence upon the course of the anesthesia. The oil of orange seems to exert this beneficial influence by dulling the sense of smell to such an extent that the odor of the anaesthetic agent is not noticeable during the administration. It has been determined by our laboratory experiments upon guinea-pigs that the oil of orange exhibits no pronounced anaesthetic effect upon these animals. The exact nature of its physiological action is, therefore, yet to be determined.

The latest development of inhalation anaesthetics is to be credited to Dr. Karl Connell, of Roosevelt Hospital, New York City. It is an evolution of the vapor method.

It consists in delivering a known percentage of ether vapor automatically and is called endopharyngeal insufflation.

Both the volume of air and the exact amount of ether by weight is known. The desired degree of relaxation can be obtained in any surgical case by calling for the desired percentage of ether.

*Intravenous anaesthesia* has won for itself within the past two years a distinct place in surgery.

The danger with this special form of anaesthesia seems to be limited to infection or embolism and as these two elements are connected with the introduction of the needle and its main-

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tenance in position without injury to the inner mucosa of the vein, this whole procedure should be relegated to the surgeon or the assistant surgeon, the anaesthetist maintaining the anaesthesia by regulating the amount of the saline ether solution into the veins.

A striking illustration of the virginity of the field of anaesthetics in other directions than those touched upon in this paper is the list of over one thousand substances recently compiled under the supervision of Prof. Baskerville (and which will shortly be published) that possess either some general or local anaesthetic property and yet only a small number of these substances have been thoroughly examined.

In conclusion, I may state that the dignity of this special field of medicine can be greatly enhanced and its progress advanced if we urge by every means possible the establishment of the condition so clearly stated by the Committee on Anaesthesia of the American Medical Association for last year as follows:

"Every hospital, certainly every large hospital, should have as a regular member of its staff an attending anaesthetist, as is the case in some, whose authority in his special department should be as complete as is that of the attending physician or surgeon in their field. This arrangement will be particularly important during the next few years when the older methods of anaesthesia will be competing with and greatly modified by newer procedures."
ACCURACY IN ANÆSTHESIA.*

ADVANTAGE, TECHNIC AND DOSAGE IN AUTOMATIC INSUFFLATION OF VAPORS AND GASES.

PRELIMINARY TABLES AND CHARTS OF ETHER ANÆSTHESIA.

BY KARL CONNELL, M.D.,
OF NEW YORK,
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Surgical anaesthesia for the half century prior to the past decade made little scientific progress. While the art of anaesthesia advanced with the increasing demands of surgery; while the lore of the individual anaesthetist was accumulated, yet each surgical narcosis was achieved according to the personal recipe of the given anaesthetist. Largely because of the difficulties of confining and measuring matter in such an elusive state as the gaseous, that precision and accuracy of dosage which came to be deemed essential in the administration of liquid and solid drugs, secured no place with the volatile anaesthetics. Anaesthetization was accomplished according to certain empirical methods and formulae, guided by the reaction of the individual.

Granting that such empiric anaesthetization in the hands of the skilled anaesthetist may be ever so perfect, yet these methods permit of no formulation, uniform results cannot be achieved, nor can methods be standardized. Further, high skill in anaesthesia by these empiric methods involves a rare natural aptitude and long training. Therefore, the trend of the present is toward that exactness of dosage and perfection of delivery, that will place anaesthesia on the basis of an exact science. This dosage in its highest refinement can only be secured by automatic mechanical measurement and delivery.

This has already been achieved with several of the more

* Read before the American Association of Anæsthetists, June 18, 1913.
desirable anaesthetics, notably ether. Indeed, it may be stated that to-day using ether as the agent, a patient may be carried by accurate automatic mechanical insufflation with an even control and a safety and precision that exact mechanical movement alone is capable of effecting, and that already by such means a mass of data has been accumulated that has placed etherization on a thoroughly scientific foundation.

The necessity of accuracy in maintaining a desired anesthetic tension in the alveolar air is obvious and the many advantages arising therefrom may be briefly enumerated, as: safety, even anaesthesia of desired depth, absolute control over this depth, and marked diminution of subsequent ether intoxication. It is true that such a drug as ethylic ether has a wide margin of safety and both in this form and as ethyl alcohol may be atrociously misused without fatal issue. Yet this misuse is not a fair standard nor should results be accepted as those of properly administered anaesthetic. In gauging the desirability of accuracy the following facts must be briefly stated.

First, the ether tension in the arterial blood to the sensorium is the determining factor of anaesthetization.

Second, this tension is established by maintaining in the alveolar air during preliminary narcosis an ether content of from 35 to 45 per cent. by weight to air under conditions at sea level, an equivalent in pressure of from 130 to 182 mm. of mercury. During the early stage of anaesthesia, say for the first twenty to forty minutes, this tension must be maintained by percentages scaling from 26 down to 15 per cent. After the establishment of anesthetic saturation of the body it is maintained by about the latter percentage, the equivalent of an ether pressure of 48 millimeters in the alveolar air.

Third, these figures probably hold for the entire animal kingdom, the variable factors seen in ordinary etherization, being these; a, the rapidity with which the body is brought to complete anaesthetic saturation, as determined by the efficiency with which the ether tension in the alveolar air is maintained by fresh delivery, by diffusion and by tidal movement; b, the rapidity of blood circulation; c, the bulk of the particular body
to be saturated and the capacity of that body for storage and destruction of the ethyl radical.

Fourth, the zones of anaesthesia above and below this saturation or anesthetic tension point are already well established for man. With absolute certainty as to the outcome man may be placed in an ether atmosphere of that percentage or vapor pressure as to produce deep, medium or light anaesthesia.

Fifth, the zone of surgical relaxation, i.e., an ether pressure of 45 to 50 mm. is a zone for many hours devoid of danger by ether intoxication.

When one links these evident advantages of a full and continuing knowledge of the dose delivered, with advantage of an even, automatic, unwearying, impersonal machine delivery of the anaesthetic agent and its menstruum, the combination works for ideal anaesthesia.

The accuracy needed for absolute control over the degree of ether anaesthesia, requires that knowledge be continual of the quantity and strength of the anaesthetic mixture delivered. In this apparatus which I now present this control has been secured. Comparable clinical results with other apparatus may be obtained empirically or by physical means, such as by thermal control of the vapor tension of ether, but in this apparatus the control is automatic and the measurement mechanical and mathematically correct. This apparatus has been in use for the past year at the Roosevelt Hospital, New York. It consists of a small portable air compressor, filter and moistener, with a maximum capacity of 50 litres per minute as a source of compressed air. In the hospital we much prefer to this source of air, the noiseless unfailing delivery from a permanent central plant.

To take up the essential instrument, this is the anæsthetometer, an apparatus to mix and measure anæsthetic and other vapors and gases. It consists of these units, a light, powerful, gas meter to measure the air, adopted as the only practical and accurate gas measuring instrument from the illuminating gas industry. This is surmounted by an ether reservoir from which is fed automatically, by the movement of the gas meter, through
an adjustable connecting mechanism, liquid ether in any desired quantity, into, third, a vaporizing chamber, warmed by electric stove and provided with thermometer, pressure gauge, instantaneous gas flow gauge and safety valve. The entire control over the percentage of ether resides in the movement of a single pin, whereby any one of sixteen percentages may be obtained with mechanical accuracy, from 2 per cent. up to 27 per cent. of ether vapor in air. Higher percentages are obtained by manual movement of a handle. A fourth feature of the apparatus, is a gas trip valve, whereby any two gases are automatically mixed in mechanically measured proportion, by each in turn actuating the meter. This apparatus has permitted the practical application of measured dose in anesthesia.

Next to discuss those factors other than accuracy in dosage, which go to make the maintenance of anesthesia automatic.

For anesthesia to be maintained automatically, at the same time safely with uniform success, requires that three factors be under the control of the operator or anesthetist: first, that complete preliminary relaxation of the individual be secured; second, that the anesthetic agent and its menstruum be so delivered as to be freely available for respiration; third, that the delivery be of such volume as to entirely supply the needs for respiration, as well as of such accurately measured and known percentage or tension of anesthetic, as to hold a given individual safely and evenly anesthetized.

Full preliminary anesthesia is best accomplished by face mask methods since man will not tolerate the introduction of pharyngeal or endotracheal tubes when conscious, nor breathe quietly in the subconscious stage of preliminary anesthesia the irritating vapors, i.e., 30 to 45 per cent. of ether by weight needed for establishment of complete anesthesia. These vapors to be inhaled quietly must be inhaled by the subconscious patient in such a way as to arouse no unusual impressions. Attempting to blow vapors of the strength needed for the induction of anesthesia into the pharynx or trachea, results in straining, coughing, gagging, and the swallowing of air. Only when the patient is completely relaxed can insufflation methods be insti-
tuted. This period of face mask delivery occupies six to twelve minutes for the most advantageous relaxation. If the operative procedure is now to occupy more than five or ten minutes, automatic insufflation may be established with decided advantage.

In this, the stage of surgical relaxation, a stage wherein life and death are nicely balanced, the patient is carried by mechanical automatic insufflation with an even precision, a perfect aeration, and a safety which the most conscientious human anaesthetist cannot duplicate.

For delivery to become automatic, the anaesthetic agent and its menstruum must be made freely available for inspiration by the delivery passing the chief obstruction, namely, the base of the tongue. Delivery by face mask requires that the mask be held and the upper gas way of the anaesthetized individual be adjusted by a practised anaesthetist.

In this connection I desire to present a new rebreathing tube, a pharyngeal tube for use in ordinary anaesthesia by face mask. With the insertion of this tube the stertor of ether anaesthesia is quieted, and in gas-oxygen delivery the percentage of oxygen may be materially lowered and the cases carried with lessened danger of sudden asphyxia. It is a flattened copper tube, curved to fit the roof of the mouth, easy of introduction, not harmful to the teeth or soft parts, nor compressible by the bite of the incisor teeth. It provides with the minimum displacement of oral structures, an abundantly free gas channel from the outer world to the lower pharynx. I like it much better than the nasal tubes, or bulky and compressible cylindrical rubber tubes for oral insertion.

To now consider the question of automatic delivery. The ideal place to deliver ether vapor in air is without question directly into the trachea by insufflation through a loose endotracheal catheter after the method of Meltzer. For effective delivery, for complete and certain aeration, for even and controllable anaesthetization, for freedom from shock and from the sequela of ether anaesthetization, this method is not surpassed.

Time does not permit me to elaborate on these nor on the various accessory advantages of this method, namely, the ability
to maintain when desired positive pressure on the interior of
the lung, and to exclude mucus and other foreign material
from the bronchial system, and to maintain if accident arises
an ideal artificial respiration.

The one and only hindrance to the establishment of the
endotracheal delivery as a routine method of anaesthesia is the
act of intubation.

This alone with its possible dangers, its ever present delays
and occasional difficulty of intubation will no doubt effectively
block the general adoption of this very useful and effective mode
of delivery as a routine method of anaesthesia.

In view of the objections to the endotracheal delivery, I have
been led to seek a method which would overcome the necessity
of intubation and the dangers of a badly supervised delivery,
yet preserve the feature most desired for routine anaesthesia,
to wit, an automatic, even, accurate, and effective delivery of
the anaesthetic agent. In the pharyngeal insufflation method of
large volumes of dilute anaesthetic agent deep into the pharynx
I believe we have such a method. The delivery is established,
after full surgical relaxation has been secured by face mask
methods. Speaking now of ether vapor in air delivery, the
essential feature of this pharyngeal method, is that a volume
of air is insufflated by positive pressure into the lower pharynx,
a volume sufficient to provide entirely for each inspiration,
without any air being inhaled by nose or mouth, and a volume
bearing a known per cent. of ether vapor in the greatest
dilution which will hold that patient evenly and safely anaes-
thesitized for the operation in hand.

The delivery is accomplished by preference through two
catheters inserted one through each nostril a distance in the
average of 12 cm.

The proper distance to insert each catheter is the distance,
measured off on the tube from its eyelet, from the auditory
meatus to ala nasi on that side. This carries the tube well into
the lower pharynx but not into the oesophagus.

The catheters selected for the adult are size 18 F, soft
rubber, velvet eye, with accessory eyelet. These are attached
to a Y metal delivery tube with bent prongs for convenience of placement and to prevent angulation and to hold the catheters in place. This Y tube accurately fits the nose and forehead and is held in place by adhesive strapped across the brow.

The volume insufflated is such as to entirely supply the needs of inspiration without extraneous dilution. This requires 18 litres of air per minute for the average adult into which is vaporized the ether.

Rebreathing is not contemplated nor countenanced in this method, no more than in the endotracheal.

The evident immunity to shock in patients carried by endotracheal delivery and a clinical comparison of many hundred of these perfectly ventilated patients to those carried by rebreathing, disproves to my mind conclusively the hypothesis that rebreathing is physiologically advantageous.

The element of economy is not worthy of consideration with ether.

However, in nitrous-oxide-oxygen anaesthesia the element of cost enters so strongly that a certain degree of rebreathing may be allowed by the following method: After the patient is surgically saturated with anaesthetic by face mask methods, the delivery is shifted to the pharyngeal method by the nasal route. Each nostril is plugged by a collar of thick rubber tubing slipped over the nasal catheter. A pharyngeal rebreathing apparatus is then inserted, consisting of the flat copper tube previously noted, with a projecting elbow, to which is attached a rebreathing bag fitted with valve escapement at the distal end. The mouth is plugged by a rubber coffer dam, carried on the flat tube. This is adjusted between the gums and lips, making a gas-tight joint. The quantity found most useful is 8 litres per minute beginning with a 5 per cent. oxygen mixture and increasing gradually up to a 9 or 10 per cent. mixture by the end of the first hour. By this volume of fresh gas and with the ease of inspiration resulting from the free gas way, the oxygen content of the gases may be decreased to the depth of 3 per cent. mixture. This percentage is highly dangerous even in large volume automatically delivered, for should delivery fail from
# Chart I

## Ether Vapor in Air

**Pressure**: 760 mm **Temp**: 22°C **Humidity**: 2.5% by volume

<table>
<thead>
<tr>
<th>Vapor Pressure Equivalent</th>
<th>Volume Equivalent</th>
<th>% by Weight</th>
<th>Zones of Anesthesia</th>
<th>Weight of Ether Gms. Per Litre</th>
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<tr>
<td></td>
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<td>BE°C</td>
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<tr>
<td>5.95</td>
<td>77.50</td>
<td>90%</td>
<td>Saturated @ 22°C</td>
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<td>0.635</td>
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<tr>
<td>1.07</td>
<td>14.20</td>
<td>30%</td>
<td></td>
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<tr>
<td>8.67</td>
<td>11.41</td>
<td>25%</td>
<td></td>
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<tr>
<td>6.70</td>
<td>8.82</td>
<td>20%</td>
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<tr>
<td>4.85</td>
<td>6.35</td>
<td>15%</td>
<td></td>
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</tr>
<tr>
<td>3.12</td>
<td>4.11</td>
<td>10%</td>
<td></td>
<td>0.127</td>
</tr>
<tr>
<td>1.52</td>
<td>1.99</td>
<td>5%</td>
<td></td>
<td>0.051</td>
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</tbody>
</table>

- **Lethal**: 50
- **Profound**: 26
- **Deep**: 22
- **Medium**: 18
- **Light**: 15
- **Subconscious**: 12
- **Light Sub-Cons**: 8
- **Confusion**: 6
any cause the respiration ceases from asphyxia, promptly. Percentages less than 6 per cent. while necessary for surgical relaxation are dangerous. In fact, the necessity for any percentage which produces noticeable cyanosis after the first five minutes of administration should brand nitrous oxide for that operation as a most dangerous method for producing surgical anaesthesia. Where surgical relaxation is desired and protection against subconscious suffering is indicated this is to be obtained, not by dangerously increasing the oxygen starvation, but by the safer, more effective means of adding ether as indicated.

I desire to emphasize that rebreathing is used solely for economy. On a pharyngeal delivery of 22 litres or five and one-half gallons a minute rebreathing may be dispensed with if the mouth be kept closed.

In summary. The pharyngeal method as carried on by the technic developed on about five hundred cases at the Roosevelt Hospital, is a method I believe that combines most of the advantages of endotracheal delivery; a method much more simply achieved and devoid of the mechanical dangers that are present in endotracheal insufflation, at the same time admitting freely, however, that the method is not so thoroughly effective in control over aération or over positive pressure, nor so effective in excluding foreign material from the larynx as the endotracheal delivery.

I venture the prophesy that the pharyngeal method of delivery will be the routine method of the future when an automatic, thoroughly controlled, ideal anaesthesia is desired through the stage of surgical relaxation.

I desire to present these charts of ether anaesthesia based on our experience with the anæsthetometer at Roosevelt Hospital. These zones and curves do not vary materially, no matter what method of delivery be employed, providing there be no dilution. The one variable, is the time and difficulty of establishing complete anaesthetic saturation, otherwise I believe these zones and curves are basic for animal protoplasm.
Chart I indicates the zones of ether anesthesia in terms of weight of ether to air delivered under working conditions. The volumetric equivalent, and ether vapor pressure equivalent, is tabulated in parallel column, as is the absolute weight of ether per litre in the air at delivery and at body temperature.

These zones are for practical working guidance in surgical etherization and are not absolute. The zones above the 15 per cent. level, gradually lower toward that level as the anesthetic tension of about 48 millimetres of
the entire body is attained. At the end of an hour of full anaesthesia, even
the zone of deep anaesthesia for a considerable length of time might result
lethally. For example, when a dog, after anaesthetic saturation, is carried
in the zone of profound anaesthesia by endotracheal delivery, respiratory
effort ceases in about an hour, only to begin again when the ether tension
is lowered. Such dosage would have resulted fatally had provision not
been made for artificial respiration. These zones are the same whether the
delivery be by face mask or by insufflation.

Chart II shows the most advantageous ether pressure to maintain
in the pulmonary air, charted in terms of weight of ether in air under
usual working conditions at sea level.

This is a composite of about 300 cases of surgical anaesthesia at the
Roosevelt Hospital, charted after a working experience had been gained
on a previous series of about 600 cases.

The percentages above 15 per cent. during the preliminary
and early stage of full surgical anaesthesia, are needed to estab-
lish the proper anaesthetic tension in the arterial blood to the
sensorium, pending such time when the entire circulating and
fixed tissues of the body are brought to uniform tension. As
seen on the chart there is a difference of 20 to 30 minutes be-
tween the length of time such saturation takes in a man of
the young robust or alcoholic type, to the much shorter time
taken to saturate the small relaxed woman and child. All
types, however, when the general tension is once established, run
on the same base line. This, for complete anaesthesia, is be-
tween 14 per cent. and 16 per cent. by weight of ether, yielding
a tension between 45 and 51 millimetres. The absolute point is
not as yet fully established but is probably about 48 millimetres.
In fact it would seem from preliminary observation that this
tension is basic not alone for all types of man, but also for
the entire animal kingdom. Below this level the operative case
may be carried where only light anaesthesia is desired, or when
the operation reaches such a stage that protection against shock
influence is no longer needed i.e., that very effective protection
conferred by full ether anaesthesia, or where the anaesthetist
desires the patient to enter the zone of slow ether desaturation
and recovering consciousness. This recovery zone may be so
gauged that in short operations the patient leaves the table prac-
tically conscious, and even after long operations in full posses-
sion of all pharyngeal reflexes.
Saturation of the arterial blood and sensorium is complete in the curve shown, to the extent of full surgical anaesthesia, in about two minutes for each litre of circulating blood, being complete in medium-sized children in six minutes and in the adult in twelve minutes. Operations, even major procedure, may be begun before full relaxation is established or at the peak of the preliminary curve, say at the end of six minutes in a docile adult. Yet where it is desired to fully protect the patient against shock producing and inhibitory influences it is desirable to wait for full surgical relaxation, i.e., about 10 to 12 minutes.

While the arterial blood to the sensorium may be fully charged by high percentages within ten minutes, yet the general body of an adult is not brought to full tension approximating 48 millimetres, by the delivery curve shown, for from forty to sixty minutes. Desaturation proceeds even more slowly, although marked changes of deadened or awakened sensibility may be seen within three minutes by increase or decrease of ten millimetres of ether vapor pressure in the air delivered. This sensitiveness is more pronounced before the anaesthetic tension of the entire body is established. Partial recovery is more rapid than deepening anaesthesia by changes of equal degree before saturation is complete. After the anaesthetic tension is established, anaesthesia may be more rapidly deepened than diminished, an observation readily explicable on physical and chemical grounds.

With these basic facts in mind, and with experience in gauging the difficulties which may arise in bringing a given individual to saturation and in planning the desaturation of that individual according to the period and need of the operative procedure, the most advantageous anaesthesia can be plotted in advance with exactness.

In closing I desire to make a plea for accuracy of dosage and for automatic delivery in anaesthesia, particularly in the stage of prolonged surgical anaesthesia.

By full knowledge of the quantity and dilution of the anaesthetic delivered, and the resultant anaesthetic percentage main-
tained in the respiratory tract, the whole control of the subject of anaesthesia lies in the hollow of the anaesthetist's hand.

The patient may be carried in the zone of profound anaesthesia, or deep, medium, or light anaesthesia at will. With the data at present in hand the most advantageous anaesthetization by ether can be plotted in advance for the type of individual and for the nature and stage of the operation, and maintained after the initial stage entirely automatically and, were it desirable, without the presence of any anaesthetist. The ether intoxication may be reduced to a small factor and shock influence effectively blocked.

It may be confidently anticipated that similar data will soon be available for the other gaseous and volatile anaesthetics.

CONCLUSIONS.

1. Accuracy should prevail with the volatile anaesthetics, as with liquid and solid drugs.

2. The content of drug per unit of alveolar air is the gauge of dose, expressed scientifically in terms of vapor pressure.

3. Such dosage is practicable by the anaesthetometer, an apparatus to measure and mix anaesthetic and other vapors and gases.

4. The advantages of accurate dosage are toward better induction and safer, more effective maintenance of any desired degree of anaesthesia.

5. The dose should suffice in volume to supply the tidal capacity of respiration.

6. The vapor tension of ether required by man is constant. This tension is probably basic for all animal protoplasm. The attainment and maintenance of ether anaesthesia may be plotted in advance.

A curve of ether pressure required in the alveolar air, plotted for the most advantageous etherization in man rapidly ascends in the preliminary stage to 130 to 182 millimetres or 35-45 per cent. by weight of ether to air at sea level pressure. After five minutes the curve falls, reaching 26 per cent. by the
tenth minute when surgical relaxation becomes well established. Through the next half-hour the curve scales downward reaching 15 per cent., or a pressure of 48 millimetres by the thirtieth or fortieth minute. On this as a base line it runs for many hours, man of every type remaining in even, safe narcosis. The pressure must be decreased when the zone of light anaesthesia or the zone of full consciousness is desired to be entered.

7. The best delivery is by mechanical insufflation of an automatically mixed and measured dose.

8. The most feasible insufflation is deep into the pharynx.

9. The most effective insufflation is into the trachea.

I desire to express my indebtedness to Dr. Walter Boothby, who, working with the same instrument at the Brigham Hospital, Boston, has checked and controlled these curves and zones, and has formulated the concept of ether anaesthetic tension, and has through wider experience in prolonged ether anaesthesia established that the base line of anaesthetic tension continues through the third and fourth hour of ether anaesthesia on man at a vapor tension of 48 millimetres.
REFLEX ACTION DURING GENERAL SURGICAL ANÆSTHESIA.*

BY CARL G. PARSONS, M.D.,
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Most text-books and the current literature on anaesthesia contain meagre articles on the subject of reflexes that relate to surgical narcosis. Perhaps the writers consider that the subject properly comes under general physiology, but as a matter of fact there are so many important reflexes which are intimately associated with surgical anaesthesia that the subject should be given special study, investigation, and prominence by anæsthetists. By a thorough knowledge of the physiological phenomena presented by the behavior of reflexes, we are enabled to determine the depth of anaesthesia and consequently to regulate the dosage of anesthetic agents. Reflexes are to a great extent guides as to the condition of the patient.

A reflex act (re, back; flectere, to bend), is an act following immediately upon a stimulus without the intervention of the will (Gould). For the production of a reflex act, three essential anatomical and physiological factors are necessary: first, an afferent nerve to receive and transmit the stimulus; second, a nerve cell centre or centres in the gray matter to receive, register, transfer, initiate, and transmit; third, a centrifugal efferent motor impulse to a muscle. This in brief is the mechanism necessary for a reflex action and constitutes what is known as a reflex arc. A suitable example of a reflex act is closure of the eyelid immediately when the conjunctiva is irritated.

In the general physiology of reflex action the reactions are divided into simple reflexes, co-ordinated reflexes, and convulsive reflexes; or partial reflex, widespread co-ordinated reflex, and widespread inco-ordinated reflex. Considered from an

* Read before the American Association of Anæsthetists, June 18, 1913.

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anæsthetist's point of view, in order to determine the degree of action of narcotic drugs on the body, a specific classification is necessary; which I have arranged as follows:

Reflexes of the Eyelid: Cutaneous; ciliary; conjunctival; double conjunctival.

Reflexes of the Eye: Tarsocorneal; ciliocorneal; corneal; pupillary, including: a, reaction to light, b, marginal motility, c, crossed concomitant, d, ciliospinal or platysma.

Reflexes of Air Passages: Nasal; pharyngeal; laryngeal; palatal; rhythmical variations of respirations.

Rectal and vaginal.

Reflex cardiac and respiratory inhibition.

Reflex cardiac and respiratory acceleration.

Miscellaneous, as cutaneous in general, abdominal, peritoneal, labiomental, vomiting; direct motor.

Following is a brief description of the above:

REFLEXES OF THE EYELID.

Cutaneous.—During analgesia, or very light anaesthesia, if the integument covering the upper eyelid is rubbed by the point of the finger, an afferent impulse is transmitted along the infratrochlear to the nasal nerve, which is a branch of the ophthalmic division of the trifacial (fifth) nerve. This impulse is transferred in the gray matter and an efferent motor impulse is sent back by the facial nerve to its terminal branches, which are the temporal and malar, and cause a contraction of the orbicularis palpebrarum.

Ciliary.—This reflex is practically the same as the eyelid cutaneous, except that the sensory irritation is produced by brushing the eyelashes, and the irritation is also taken up from the lower lid by the palpebral branches of the infra-orbital of the superior maxillary of the fifth nerve. It is of value in light nitrous-oxide-oxygen anaesthesia.

Conjunctival.—Irritation of the conjunctiva causes an impulse to be taken up by the infratrochlear and palpebral branches of the trifacial nerve, which is reflected to the facial
nerve and causes contraction of the orbicularis, or a portion of it.

*Double Conjunctival.*—This reflex is the same as the conjunctival, except that both lid margins are stimulated at the same time. The afferent nerve terminals are separate and a greater "signal surface" is irritated. This reflex is of practical value during gas-oxygen analgesia or anaesthesia.

**REFLEXES OF THE EYE.**

*Tarsocorneal (Parsons' reflex).*—I wish to elaborate on this particular reflex because for eight years I have been investigating the anatomical, histological and physiological phenomena concerned in its production, and also its clinical application. So far as I am aware, this specific reflex has never been described except by myself, in 1907 (*Denver Medical Times*, August, 1907, p. 40). This reflex is produced as follows: The superior palpebral portion of the orbicularis is gently retracted upward by the anaesthetist's index, or preferably the middle finger, and by steady pressure the ciliary margin of the tarsal plate is pressed against the cornea directly over the pupil. The reaction which follows is a lateral movement of the lower lid toward the nose. To understand this particular reflex definitely, it should be considered from an anatomical, histological and physiological standpoint:

(a) **Anatomy.**—It will be remembered that the orbicularis palpebrarum is a sphincter muscle with its tendinous portion, including the tendo oculi, situated at the inner angle of the orbit. The muscle itself consists of two distinct portions, *i.e.*, the palpebral portion (ciliaris) covering the eyes, which is thin and pale and possesses involuntary action; and the orbicular portion (orbicularis latus) which is thick and of a reddish color and surrounds the orbit. Another distinct muscle, the tensor tarsi (Horner's muscle), a small thin muscle which arises from the orbital surface of the lachrymal bone and is inserted into the tarsal plates, plays an important rôle in this reflex. The nerves concerned are the long ciliary nerves of the cornea from the nasal branch of the trigeminus, the short ciliary branches from the ciliary ganglion, the temporal and malar branches, and the infra-orbital branch of the facial, the last inervating the tensor tarsi. The superior tarsal plate is composed of dense connective tissue and is about one-third of an inch in breadth at the centre. The free or ciliary margin
is thick and presents a perfectly straight edge. The inner angle of the plate is fixed to the margins of the orbit by the tendo oculi.

(b) Histology.—The cornea consists of a number of layers, the anterior being of stratified nucleated epithelium connected by delicate processes of protoplasm. Beneath the epithelium is a network of non-medullated nerves (from the ciliary) known as the subepithelial plexus, which branch into naked fibrille and ramify between the epithelial cells, the intraepithelial plexus, and terminate as minute fibres with spherical end bulbs, which are exceedingly sensitive.

We now come to a physiological consideration of the tarsocorneal reflex and its clinical application. When the straight edge of the tarsal plate is pressed against the cornea, its sensitive nerve endings are irritated and a centripetal afferent impulse is conducted by the trifacial nerve to the gray matter, is there transferred and a motor impulse is sent back via the facial nerve to muscles which cause a lateral retraction of the lower eyelid toward the nose. A mesial contraction of the orbicularis is inevitable because the tendinous structures are situated at the internal aspect of the orbit. Also the tensor tarsi on contraction pulls the tarsal cartilages inwardly especially the inferior plate.

Variations in the reflex action are due to many causes. Narcotic drugs will diminish the excitability of the reflex arc. Neurotic individuals present an active reflex. Repeated attempts to elicit the reflex will cause fatigue and consequently a diminished or no reaction. When Horner’s muscle is very indistinct, as it occasionally is, the strength of the reflex is diminished.

Lastly, the amplitude and activity of the tarsocorneal reflex diminishes directly as the depth of anaesthesia, and is therefore a valuable anaesthetic guide. The retraction of the lower lid in surgical anaesthesia (third stage) may only be 1/64 of an inch in amplitude. This reflex is practically as sensitive as the direct corneal produced by touching the cornea with the finger tip—a practice which is non-surgical.

Ciliocorneal Reflex.—This reflex is produced by causing the eyelashes of the upper lid to touch the cornea. The reaction is the same as the tarsocorneal or corneal.
**Corneal Reflex.**—The corneal reflex is essentially the same as the tarsocorneal, except that the afferent impulse is produced by direct irritation of the delicate corneal surface, usually by the point of the finger. It is bad practice to induce the reflex in this manner, as a number of corneal inflammations and ulcers have resulted from this procedure.

**Pupillary Reflex Action.**—The pupillary reactions are extremely valuable guides as to the condition of the patient during anæsthetization. In some cases the pupils are so modified by drugs, type of patient, etc., that they lose their full value as guides, but even then if interpreted correctly they serve as definite indicators of the effect of the anæsthetic.

(a) Reaction to Light.—When the lid is opened and the eye exposed to light, the pupil contracts. The light irritates the retina, which sends a centripetal impulse to the brain via the optic nerve, the efferent channel being the third nerve (ciliary ganglion and short ciliary nerves) which causes contraction of the iris. Patients with an Argyl-Robertson pupil do not react to light during narcosis, but marginal motility is present.

(b) Marginal Motility (Described by J. B. Morrison, *N. Y. Med. Jour.*, 1898).—During surgical anæsthesia if the eyelids are retracted and the eyes exposed there is seen an alternate non-rhythmic contraction and dilatation of the pupils. This is due possibly to a physiological battle between the third nerve, which contracts, and the irritated sympathetic (from operative manipulations) which dilates the pupil.

(c) The crossed concomitant pupillary reflex is produced by keeping retracted the upper eyelid of one eye while the lid of the other eye is alternately opened and closed. The pupil dilates in the exposed eye when the lid of the opposite eye is closed, and contracts when the lid is opened. This bilateral phenomenon is dependent upon the decussation of the optic nerves, and upon the activity of the reflex the depth of anæsthesia is based.

In the lighter stages of anæsthesia, the pupils are reflexly dilated from various afferent causes. During surgical anæsthesia (third stage) the pupils are contracted (unless modified by drugs, or in the persons of neurotic subjects) due to the predominating influence of the third nerve, the afferent impulses being held in abeyance to a great extent. If for some reason the patient enters the fourth stage of anæsthesia, paralytic (passive) dilatation of the pupils occurs. The differential
diagnosis between physiological reflex dilatation and pathological paralytic dilatation of the pupils is given in the following table:

**REFLEX DILATATION.**

Pupil is bright, mobile, liquid, life-like hue.
Other reflexes usually present.
Patient shows signs of "coming out."
Marginal motility of the iris is present.
Eye-balls may roll.
Reaction of pupil to light.
Not enough anesthetic has been given, determined by clinical experience.
Respiration and circulation in fair condition.
Skin has good color.
Eyelids usually closed.
Tonicity of eyelids is present.
Tears are not markedly secreted.
More anesthetic will contract the pupil (third stage).

Less anesthetic will cause pupil to remain large (reflex dilatation).

**PARALYTIC DILATATION.**

Pupil is dull, sluggish, immobile, death-like condition.
No reflexes of any sort present.
Entire body relaxed.
No marginal motility is present.
Eye-balls are fixed.
No reaction of pupil to light.
Too much anesthetic has been given, or not enough, resulting in reflex cardiac inhibition.
Respiration and circulation failing.
Skin is cold and clammy; pallor or lividity.
Eyelids remain partly open, due to relaxation.
No tonicity of eyelids.
Increased secretion of tears.
More anesthetic will produce still wider dilatation, plus respiratory and cardiac arrest.
Less anesthetic, or none, will cause the pupil to contract back to third stage.

*(d)* The *ciliospinal* or platysma reflex is of value to determine false or spurious anaesthesia. Very often when children inhale a few breaths of anaesthetic vapor (chloroform usually) they pass at once into a natural sleep. The pupils become exceedingly small, the lid reflexes are absent, the lower jaw is relaxed, the respirations are quiet, there is general muscular relaxation, and the patient appears as if in deep anesthesia. If an incision were made at this time the patient would cry out and immediately be wide awake, or a reflex cardiac inhibition might occur, which might prove fatal, especially if chloroform were being used. To determine this state of pseudo-anæsthesia, the patient's neck (platysma myoides) is pinched or tapped with the fingers and a pupillary reflex dilatation takes place, indicating more anaesthetic. The reflex in this case is caused by stimulation of the ciliospinal centre, which controls the dilatation of the pupil. This centre (Budge's ciliospinal centre) is situated in the lower cervical region, extending downward to the level of the first to third thoracic nerve.
REFLEX ACTION DURING ANÆSTHESIA.

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REFLEXES OF THE AIR PASSAGES.

These reflexes occur during the lighter stages of anæsthesia. The nasal reflex is sneezing when the schneiderian membrane is irritated by a too concentrated anaesthetic vapor. The palatal reflex causes gagging and swallowing movements, and often leads to vomiting.

The pharyngeal reflex occurs when the pharynx is irritated, the reaction being swallowing movements, or gagging. The laryngeal reflex is coughing, caused by irritation of the fauces, larynx and neighboring structures.

Reflex inhibitions may also occur from this site. "Crowing" breathing may be reflexly excited by manipulations of the surgeon in abdominal operations.

The "expiratory phase of Crile" is a grunting expiration during operations within the upper abdominal cavity, and the "inspiratory phase of Crile" is a noisy inspiration during operations in the lower abdominal cavity.

Of especial clinical interest is spasm of the glottis, with complete closure of the rima glottidis, produced reflexly by irritating vapors, usually ether, and often occurs during fairly deep anæsthesia. The stridor may persist and tongue traction be of no avail. Laryngotomy or tracheotomy may be necessary in obstinate cases. Spasm of the glottis also may be produced reflexly by afferent impulses from various parts of the body, as from the perineum. Rhythmical variations of the respiratory act may occur reflexly from various centripetal impulses, produced by the operative procedure and are of three types, viz: those that accelerate and those that inhibit respiration, and those that cause intermittent breathing.

Rectal Reflex or Anorespiratory.—When the rectum is dilated, the reaction produced is a sudden inspiration. The same obtains when the vagina is dilated. In any case that has entered the fourth or paralytic stage of anæsthesia, dilatation of the sphincter ani often sets the respiratory pump in action in conjunction with other means of resuscitation.
REFLEX CARDIAC INHIBITION.

Under this heading a few important considerations relative to anaesthetics will be taken up. When a patient is in incomplete anaesthesia (particularly during chloroformization) the heart is especially susceptible to reflex inhibition, and if during this stage operations, even trivial, are begun the heart action may be arrested, and, indeed, many deaths have occurred in this manner. The principle causes of this dreaded phenomenon are afferent impulses acting reflexly upon the inhibitory fibres of the vagus; fear; irritating fumes of a concentrated chloroform vapor acting reflexly upon the sensitive mucous membrane of the air passages; directly by sudden anæmia of the medulla. Reflex cardiac inhibition is prevented by the preliminary use of atropin (this drug augments the heart beats by paralyzing the inhibitory mechanism); by a gradual administration of the anaesthetic with plenty of air; by having the patient in the third or surgical degree of anaesthesia; and by keeping the intracardiac pressure up to par. Clinically, reflex cardiac inhibition occurs most frequently when very sensitive areas are irritated, as operations about the distribution of the fifth nerve; laryngeal operations; circumcision; avulsion of the finger or toe nails; curetting a sensitive cervical canal. Care should be exercised in using the faradic current about the vagus and its branches.

REFLEX CARDIAC ACCELERATION.

The centre for the augmentor nerves of the heart is probably situated in the bulb. Stimulation of afferent nerves in the lighter stages of anaesthesia causes a more rapid heart beat by reflexly stimulating the sympathetic nerves of the heart (providing reflex inhibition does not occur) the augmentor centre ordinarily being more easily excited than the inhibitory. The comparative pulse rate during anaesthesia is an indicator of the depth of narcosis.
REFLEX ACTION DURING ANÆSTHESIA.

REFLEX RESPIRATORY INHIBITION AND ACCELERATION.

The same general rules apply to the respiratory action as for the cardiac action, but to a lesser degree. During the surgical procedure the pulse and respiration vary in rate, more fluctuation being present during the lighter stages of anaesthesia.

MISCELLANEOUS REFLEXES.

General Cutaneous.—If the patient is too lightly anaesthetized and an incision is made, flinching occurs and disaster may result from reflex cardiac inhibition, especially when using chloroform.

Abdominal-Peritoneal.—The parietal peritoneum is a sensitive “signal surface,” and deep anaesthesia is often necessary to overcome the reaction, which is a rigid abdominal wall. With nitrous-oxide-oxygen anaesthesia this reflex is the surgeon’s bane, but relaxation can be greatly overcome by proper technic.

Labiomental Reflex.—Dastre discovered a reflex which he termed labiomental or “ultimum reflex.” He found that by irritating the upper gum (in dogs) a reflex retraction of the lower lip occurred. Perhaps this led to the well-known and valuable lip-friction, which reflexly stimulates respiration (labiorespiratory reflex). Brisk rubbing of the lips often prevents threatened anaesthetic syncope from becoming fatal.

Vomiting during anaesthesia occurs only during the lighter stages and is due to a number of causes. Ankle clonus, ether-tremor, and exaggerated knee-jerk when present are exhibited during the second stage, but had best not be classed as true reflexes.

No doubt there are many other reflex phenomena concerned in surgical anaesthesia, and it is the hope of the writer that continued scientific investigation will be conducted in this field by anaesthetists.
INTRAVENOUS ANÆSTHESIA.*

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AND

J. WYLLIS HASSLER,
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The exacting demands of both operator and patient in the surgery of the present day have taxed the skill and resources of the expert anæsthetist to the uttermost limits and have caused him to explore all fields which give any promise of anæsthetic possibilities. The layman, with a somewhat exaggerated idea of the safety of modern surgical operations, usually disregards the potential factor of danger present in all operative procedure but invariably seriously considers the probable risk from the administration of an anæsthetic. The surgeon insists upon a period of stable anæsthesia of indefinite duration, with complete relaxation of the musculature of the patient, minimum risk, freedom from postanæsthetic nausea and vomiting, and finally the absence of those more serious complications of the post-operative stage, which are now believed to be the direct result of the narcosis. These post-operative complications, which may be immediate or remote, have been very closely studied and are variously supposed to be the direct irritating effects of the narcotizing agent—in some cases amounting to actual degeneration of tissues with a more or less constant and definite pathological picture. Crile's wonderful observations and experiments, conducted with a scientific acumen and judgment amounting to a veritable inspiration, have set other standards and have established principles that introduce an entirely new era in anæsthesia. He has demonstrated, beyond the shadow of reasonable doubt, that during operations conducted under the usual methods of ordinary inhalation anæsthesia, traumatic impulses from

* Read before the American Association of Anæsthetists, June, 1913.
the operative field are constantly bombarding the cerebrum, that the tissues, nerve tracts and portions of the sensory portion of the brain, are keenly awake and alive to these harmful associations, and that the subjective mind is not narcotized,—only imprisoned. Furthermore, that the involuntary struggles of the patient not deeply anaesthetized, and which have always been considered simply reflex and without importance except to indicate the necessity of more anaesthetic, are in reality motive efforts on the part of the patient to escape the operative trauma, such movements, excited by irritation, being a heritage of experiences from the patient's phylogenetic ancestry.

It has long been known that the vasomotor, cardiac and respiratory centres in the medulla discharge nervous energy in response to stimuli applied to various sensitive portions of the body during surgical anaesthesia. If the trauma is sufficient, exhaustion of the entire brain is observed after the anaesthetic effects have worn off, that is, despite complete paralysis of voluntary motion and loss of consciousness, due to ether, the traumatic impulses reach the wide awake centres in the medulla and also in every other portion of the brain. If, however, the nerve tracts from the field of operation be blocked with cocaine, and the element of fear be excluded, despite the intensity or the duration of the trauma within the operative zone so blocked, no exhaustion follows after the effects of the anaesthetic have worn off and no degeneration is apparent in the brain cells. It is therefore manifestly clear that ether, by inhalation, is but an "anaesthetic veneer" which, while it produces unconsciousness, apparently protects none of the brain cells against the trauma of a surgical operation.

This proposition, it is claimed, explains why, in the employment of the usual methods of inhalation anaesthesia, a robust patient may go to an operating room for an operation of an hour's duration, to emerge beaten, broken and shattered, and in such condition that months, or even years, may intervene before he recovers his normal status of health. The operation of these injurious impulses during surgical procedure Crile calls "noci-association," and that state which he obtains by employing certain methods of nerve blocking to pre-
vent these traumatic impressions from reaching the cerebrum, he calls "anoci-association."

From the foregoing, it is evident that progress in anaesthesia, whether it concerns method or agent employed, must incorporate in its possibilities all of the factors concerned in the production of anoci-association. We are strongly of the opinion that no method, however much it has to commend it, will not meet the new standard set by Crile unless by its employment the patient is anaesthetized quickly and pleasantly, that is without the sensation of suffocation or strangling and with the absence of a stage of excitement. The patient should pass into a narcosis closely simulating normal sleep, should be completely relaxed so far as the muscular system is concerned and, during a long and even trying operation, the pulse and respiratory wave should be subject to very little variation; the patient should awaken promptly after the operation, there should be no nausea or vomiting, comparatively little or no post-operative pain, no unpleasant after-effects of any kind that leave disagreeable memories on the mind of the patient. These are the advantages claimed by Crile when he employs gas and oxygen anaesthesia with nerve blocking from the operative field with urea and quinine hydrochloride. These conditions may be duplicated with intravenous anaesthesia with even some additional advantages. In the preliminary reports of our experiences we were careful to explain that this method would have, in all probability, a comparatively restricted though definite field of usefulness, but its continual employment, not only in private practice but in a hospital where the anaesthetic risks are probably greater than anywhere in this country, has surpassed any form of anaesthesia ever employed in the institution.

Like many discarded or forgotten surgical procedures which, when revived, interest the medical profession by the charm of apparent novelty, general anaesthesia by the intravenous route was demonstrated as a possibility by Orè, in 1872, who used chloral hydrate as the hypnotic agent and whose report (published that year) covering every detail of his experi-
ences, is of extreme interest. He had considerable success in 51 cases but after a few fatalities, due perhaps both to the method and the drug employed, he discontinued its use. In 1909, Burckhardt, after extensive animal experiments, became enthusiastic over the intravenous method and attempted its use on the human subject, using chloroform at first but soon discarding it for ether, which he found quite as efficient, and much safer. At the Berlin Surgical Congress in 1910, six surgeons of prominence corroborated the success of Burckhardt, Kummel reporting 90 cases in his own experience, believing that it was particularly useful in aged and cachectic individuals.

Later, Fedoroff of St. Petersburg collected 530 cases from 3 Russian clinics, in which hedonal had been used in the same way and, although the cases embraced all kinds of surgical operation, there were no deaths attributable to the anaesthetic. Eight cases of temporary respiratory arrest, however, yielded to simple methods of artificial respiration. Up to this time, the method of induction of anaesthesia in this manner was somewhat crude, as Kummel pointed out, not free from danger, particularly of thrombosis. Burckhardt employed a simple infusion apparatus from which a mixture of a 5 to 7.5 per cent. of ether in normal saline solution was allowed to flow through a cannula into a convenient vein, usually the median basilic, until a sufficient narcosis was established to proceed with the operation. The flow was stopped by compression of the rubber tube, connected with the cannula, until the patient began to show signs of returning consciousness, when the solution was again admitted to the circulation, and so on until the operation was completed. Fedoroff and his colleagues used a 0.75 per cent. of hedonal in normal saline solution, in much the same way except that the cannula was entirely withdrawn from the vein to be reintroduced into a fresh one when more anaesthesia was required. Kummel sought to obviate the danger of thrombosis by providing two tanks, one with normal saline and the other containing the anaesthetic solution, both being connected with appropriate control stop-cocks and a Y-connection so that,
even though the anaesthetic solution was cut off, the normal saline flow could be continued, and thus the circulation in the vein at no time be absolutely stopped. This method did not give a smooth, even anaesthesia and finally Rood devised a most ingenious apparatus, safe, simple, and efficient, which has answered all the requirements for maintaining a continuous, easily regulated flow, which may be kept at a uniform temperature, and places the degree of narcosis quite within the easy control of the anaesthetist.

We have constructed such an apparatus, largely from materials at hand, with a justifiable spoliation of some of our other equipment, which has embodied all of the essential features of Rood's valuable suggestions, so that the use of this method of anaesthesia does not necessitate a very expensive outlay (see Fig. 1).\(^1\)

It should be understood at the outset that this procedure is not urged to supplant any of the well recognized forms of anaesthesia in general use, nor do we entertain the hope or belief it will become the method in universal use. We are convinced, however, that, with further experience and development, its efficacy and safety will assign it a definite field of usefulness. In the generally employed method of respiratory anaesthesia, some volatile agent is introduced into the circulation by way of the lungs, the rate of introduction being affected by certain variable factors, the energy and depth of the respiratory effort, laryngeal and respiratory spasm, the condition of the bronchial mucous membrane, and the skill of the anaesthetist. There are, of course, many other conditions which modify the amount of anaesthetic required to produce surgical narcosis in a given subject, but those mentioned are present as variable factors in every case where the indirect or respiratory method is employed. It is manifestly clear that, under these conditions, in every case of anaesthesia produced in this way, more of the anaesthetic is introduced into the body than is necessary, the excess is stored up in the tissues to be gradually

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\(^1\) The Kny-Scheerer Co., of New York, has made a very satisfactory apparatus, after our designs, for intravenous infusion anaesthesia.
eliminated, a matter of several days duration, with often the
unpleasant, if not serious consequences, which mark the toxic
effects of the drug employed. The delayed effects of anes-
ethetics, after narcosis and after the patient has recovered from
the shock, and other more or less immediate results of the
operative procedures are worthy of closer and more extended
study. It is reasonably certain, in the minds of most ob-
servers, that acute yellow atrophy of the liver (or a poisoning
of the hepatic cells and interference with their metabolic ac-
tivity), injuries to the myocardium, and the developments of
a state of acidosis allied to diabetic coma, are occasional late
sequences of chloroform administration. The well-known
irritating effects of ether upon the respiratory apparatus and
the kidneys are well understood. The evil effects of any anes-
thetic do not depend upon the amount taken into the lungs but
the amount absorbed from them by the blood, and again the
amount absorbed by the tissues from the blood, and especially
those tissues of the nervous system which are intimately as-
sociated with vital functions.

It must be borne in mind, as pointed out by Buxton, that,
if the administration of an anesthetic is kept at the same level,
narcosis will deepen, and if the anesthetic is a stimulant, such
as ether, the initial stimulation of the nervous system gives
rise to an ever-increasing exhaustion. If the anesthetic is a
depressant, such as chloroform, its maintenance at the same
level of strength will turn depression of function into pro-
found exhaustion. However slight may be the degree of
respiratory failure, it leads to diminished pulmonary ventila-
tion, and this to lessened oxidation which, with failing blood-
pressure, causes the tissues of the body to be enfeebled to the
point of being rendered moribund.

The correct interpretation of the situation is the recognition
of the anesthetist of the fact that, when once a level of narcosis
sufficient for the purposes of the surgeon is reached, very little
anesthetic is necessary to maintain that equilibrium once it is
established, and that, so long as the tissues are not over-
narcotized, the cells will part with the anesthetic and regain
their normal physiological status when the administration of the drug is withdrawn.

In the employment of intravenous anesthesia, the agent is directly introduced into the blood, a minimum amount is used, it is maintained there at a certain definite percentage, and its employment can be withdrawn abruptly without storing up in the body reservoirs such excess as may subsequently prove harmful to the patient. In this method the production of anesthesia is very rapid, the preliminary state of excitement is nearly always absent, the patient breathes almost naturally, the color of the skin remains good, and the relaxation and flexibility of muscles are absolutely satisfactory to the operator. The degree of narcosis can be maintained to a nicety and at the completion of the operation the patient often answers questions rationally before leaving the operating room, and returns to bed with better physical signs than before the anesthetic was administered.

For the safe and satisfactory induction of anesthesia by the intravenous route it is highly essential that the details of the technic, which is remarkably simple, be carefully and systematically observed. It is very remarkable that trained anesthetists have failed utterly with this method in the first attempts because they neglected to familiarize themselves with a few important principles which are absolutely necessary if this method is to be successfully employed. Failures to obtain a satisfactory degree of narcosis, unfortunate complications and even fatalities have occurred which, in our judgment, are utterly unwarranted. In a very active surgical service at the Metropolitan Hospital, Department of Public Charities, Blackwell's Island, the bete noir of the surgeon has always been the anesthesia. The patients for the most part are from the poorest quarters of the city, reduced by privation, hard work, poor hygienic conditions, alcoholism and pre-existing disease. They are frequently extra hazardous risks viewed from either an anesthetic or surgical stand-point; but such has been our experience with intravenous anesthesia that, in that institution, it is the safest, most efficient, freer from post-operative com-
intravenous anaesthesia. 907

complications than any form of narcosis ever employed in the history of the Hospital. Our work has embraced about all of the operations usually performed in a large general surgical service, males, females and children and, at the present time, we can recall only one death in about 350 administrations that could be justly attributed to the method of anaesthesia and in that single instance the regrettable fatality was due to the unfortunate misunderstanding of a verbal order as to anodynes after the operation. Our first experience was with the simple infusion apparatus as recommended by Burckhardt, the originator of the method, but subsequently we used the more elaborate and satisfactory technic of Rood.

For the intravenous use of ether, the patient, having been prepared for operation, is taken to the anesthetizing room about thirty minutes before the time for operation and placed preferably upon the operating table which is to be used during the operation. A subcutaneous injection of morphine sulphate, gr. 1/6, atropine sulphate, gr. 1/100 and scopolamine, gr. 1/100, is given at one dose, preferably in the loose tissues of the chest, abdomen or thigh. From this time until the actual anaesthesia is accomplished, it is extremely advisable to keep the patient as quiet as possible so that, when the administration begins, the patient is in a condition of reposeful relaxation of mind and body. No matter how anxious or fearful of the result of the operation, the patient in thirty minutes is sustained and supported by the hypodermic medication and the injurious effects of acute fear, which Crile has demonstrated are identical with those of acute shock, are successfully combatted. A five to seven and one-half solution of ether with filtered sterile Ringer's solution (normal saline solution may be used if the other is not available), at a temperature of 85° F. is poured into a reservoir which has a capacity of 2000 c.c. The solution is thoroughly mixed and care should be taken to see that the ether is thoroughly dissolved, for even after violent succession there may be some stratification, the lighter ether floating upon the surface of the solution. At that temperature ether is soluble in about 10 parts of normal saline solution. It is
important to note that the introduction of a large amount of solution at a temperature so much lower than that of the body produces no harmful effects, either immediate or remote. It is noteworthy to add that ether boils at 96° F. and even before that point is reached, it will have vaporized and escaped, thus offering an explanation of the failure to produce anaesthesia when ether was added to a normal saline solution, the temperature of which was at or near 96° F. with a mistaken idea that it would better conserve the vital forces of the patient.

The solution having been prepared, the reservoir is adjusted on a stand eight feet above the floor level, at which point it remains during the administration. The fluid flows through an indicator (which contains a pipette) then through a rubber tubing into a blunt cannula and so into the vein. The indicator consists of a cylindrical or globular bulb of a capacity of from two to four ounces with an inside pipette very similar to that used in the Murphy apparatus for protoclysis. When the apparatus is working properly, the lower half of the indicator is filled with solution while the upper half contains air. The solution flows from the tank through the pipette and drops on the surface of the fluid in the lower half of the indicator. By means of a compression top, placed below the indicator, the rate of flow can be accurately controlled and, if the fluid in the bulb is kept at a proper level, a satisfactory index is furnished as to the rate the solution enters the vein (Fig. 1). Usually the arm furthest from the operator is selected and the median basilic or cephalic vein exposed, but should the operative field be the skull, face, neck, or chest, where the infusion apparatus would inconvenience the surgeon or his assistant, the internal saphenous at the internal malleolus is selected. As a matter of fact, any vein, in any locality remote from the operator, may be utilized, the simple precaution being that it is superficial, free from varicosities, and sufficiently large to be readily exposed and to admit the small cannula through which the anaesthetic solution is to be introduced into the system. If the elbow is selected, a padded splint, large at one end and tapering to a size somewhat wider than the forearm is placed beneath the
An apparatus designed for use in any form of intravenous anesthesia. The narrow tube by the side of the reservoir is for the introduction of a solution of hedonal or isopral preliminary to the employment of a solution of ether.
Vein has been exposed and ligated distally, this ligature not shown in illustration. Vein is being opened with scissors.

FIG. 2.
Cannula introduced and tied in the vein.
Patient under anesthesia by intravenous method. Note globular indicator with control stopcock. Also method of maintaining arm in proper position.
Another model apparatus for intravenous anaesthesia in which the reservoir and tube for preliminary narcosis is in one piece, and the solutions controlled by an ingeniously perforated glass stopcock.
patient, extending from beyond the tips of the fingers to the opposite side of the body; a few turns of a three-inch bandage just above the wrist will maintain extension of the forearm and prevent involuntary movements which might occur in the first stage of anaesthesia and dislodge the cannula from the vein, an embarrassing but easily preventable accident. A space of about four to six inches over the bend of the elbow is now firmly wiped once over with a 5 per cent. solution of thymol in carbon tetrachloride, on a piece of gauze. This is sufficient to thoroughly sterilize the skin, which has not received any previous preparation. It has an advantage over iodine, usually employed, in that it is more efficacious and, as an antiseptic, does not discolor the skin, the latter a great advantage when superficial veins are to be dissected. It is not advisable to bandage the distal extremity of a limb to render the veins more prominent as the compressor must be very quickly removed when the cannula is introduced and that often adds to the difficulty. If the veins are not particularly prominent, an assistant may make some pressure with the hand on the upper and inner aspect of the arm while the vein is being exposed. There should be no blundering at this point, since nothing so disturbs the morale of the patient, destroys confidence and adds fear and anxiety, when composure should be supreme, as the futile, clumsy attempts to find the vein by anaesthetists not accustomed to doing surgical work.

We make it very emphatic that the exposure of the vein and the introduction of the cannula should be done by the operating surgeon, the anaesthetist taking charge of the apparatus and watching the respiration and cardiac action. It is important that this small but important step be done with scrupulous regard to asepsis, since septic thrombosis at this point might lead to unpleasant after results. The anaesthetist therefore relieves himself of a burden of considerable responsibility when he relegates the surgical part of this procedure to the experienced operator. The skin over the vein selected is infiltrated with a few drops of one-half of one per cent. solution of cocaine, sufficient to make a bleb one-half inch in
diameter. The skin containing the bleb is drawn aside from the vein with the thumb of the left hand so as not to be directly over the vein, and a small incision one-third to one-half an inch made through into subcutaneous fat. The vein is now exposed by wiping with a bit of gauze for two or three firm strokes. A small haemostat, with a double ligature of No. 1 catgut, is now carefully thrust beneath the vein and, by gently moving it horizontally in and out, the vessel is lifted from its bed and the exposure is complete. The ligature is cut, the lower half is tied tightly and attached to a haemostat, the upper half being tied loosely with half a knot and also clamped with a haemostat. The operator now takes the proximal ligature in his left hand, the assistant making slight tension on the one distal; the vein is lifted and put somewhat on the stretch. With a small rather blunt scissors an incision is made embracing about two-thirds the calibre of the vessel (Fig. 2). The operator now takes the cannula in his right hand and, slightly relaxing tension on the proximal ligature which he holds, he is able usually to quickly insinuate it into the cavity of the vein. By manipulating the proximal ligature as to tension, he is able to facilitate this movement, though it is often advisable to have the assistant pick up the flap of the incised vein with a small pair of anatomical forceps which exposes the lumen, steadies the vessel and very considerably facilitates the introduction of the cannula. The half loose knot in the proximal ligature is now drawn snugly down on the cannula, which is sufficient to hold it in place (Fig. 3). A piece of adhesive plaster about 3 inches wide is placed about the rubber tubing connected with the cannula, which relieves all tension and tends more than anything else to prevent the accidental slipping of the tube from the vein. A large gauze pack is now placed over the incision and the surgeon and assistant take their respective places to begin the contemplated operation (Fig. 4). We have found that actual exposure of the vein and tying on of the cannula is the most satisfactory and safe procedure, many suggestions having been made as to the use of a technic similar to that employed in the salvarsan treatment, special needles have been
made and tried only to return to the very satisfactory procedure described above.

The solution should be administered at a full flow at the beginning, the anaesthetist reducing the stream at the appearance of the usual signs of surgical anaesthesia. It is quite as incumbent upon the anaesthetist to take the usual precautions to secure and maintain an unobstructed air-way and efficient respiratory act, as in the usual method of anaesthesia. Ether is rapidly eliminated by the lungs in this method, and, as is true of all methods, efficient respiration prevents accumulation and tension on the tissues, increases its output, and lessens its toxicity. In from one to five minutes anaesthesia will be complete and the operation may proceed.

It is highly important, as was noted above, to be economical in the use of the anaesthetic solution; the patient should be placed in the appropriate position for the intended operation, the operative field draped, the skin disinfection completed, and the surgeon absolutely ready to make the initial incision when the cannula is inserted into the vein. There is a limit to the patient's tolerance for even salt solution, and it is very desirable that any portion of the period of anaesthesia be not wasted upon preparation but reserved solely for the actual operative technic. When the degree of narcosis is obtained, which varies somewhat with the nature of the operation, the flow into the vein is reduced by the control-cock just below the indicator. It may be allowed to drip in a very fine stream or at the rate of 40 to 60 drops per minute, the corneal reflex affording a reliable guide for administration. The anaesthetist readily becomes acquainted with the effects of the drug by this method, and as narcosis can be absolutely and beautifully controlled, there is no need for any embarrassment to the operator from involuntary muscular contractions. Again let it be urged that careful attention be directed to the maintenance of an open air-way, and as the muscles of the jaws and neck are very much relaxed, the tongue should not be allowed to drop back into the pharynx. It is more important to attend to these respiration precautions than if the patient were being
anaesthetized by the inhalation method. Latterly we have found the use of the Hewitt breathing tube very useful in assisting to maintain proper air-way and also as an aid to holding the tongue forward. Our usual practice is to fix the tongue with a pair of fine tenaculum forceps and let them hang by their own weight. We advocate a continuous flow in intravenous anaesthesia, no matter what agent is employed as the hypnotic, though a few times we have interrupted the stream for a few moments without any appreciable harmful effect at the conclusion of the operation unless it has been quite prolonged; particularly if ether alone has been used, the dressings should be applied before the flow is actually stopped, as the return to consciousness often comes very promptly and the patient may resist efforts to finish the toilet of the incision properly. The blood-pressure rises slightly with the use of ether in this way—we use it preferably in the old and cachectic patients, avoiding its use in young, full-blooded, or alcoholic subjects.

Oozing is more noticeable, perhaps, in the operative field, and, if the cavity of the abdomen is the seat of the operation, fluid rapidly accumulates there. If extensive adhesions are to be dealt with, the fluid rapidly becomes blood-stained, and there might be instances where this might embarrass and delay the operator, but we have not been so troubled. The patient may be brought from one degree of anaesthesia to another very rapidly by the judicious use of the control indicator, and it is well that the operation be entirely finished and dressings applied before the administration is stopped, as the patient returns to consciousness very quickly. If the administration has been skilfully performed, the patient will quietly drop to sleep without any appreciable indication of a stage of excitement. The face will flush, eyes roll and some of the voluntary muscles stiffen for perhaps a few seconds, when suddenly the patient seems to have fallen into a quiet but deep sleep without the noisy stertorous respiration usually associated with narcosis. The usual signs, corneal reflex, pupillary indication, etc., are about as noted in the same degree of anaesthesia.
by the inhalation method. At the conclusion of the operation, which may last from two to three hours, at the expenditure of about 1000 c.c. of solution per hour, the cannula is withdrawn by a quick jerk from the vein, the loose half knot of catgut is tied which ligates the proximal portion of the vein. The wound is closed with a few fine silk sutures of 000 silk on No. 10 straight needles, wiped once with carbon tetrachloride and thymol, 50 per cent. solution and an aseptic dressing applied. The patient is returned to bed and, if much solution has been used and the operation prolonged, a semi-Fowler position is employed and the nurse instructed to turn the patient every one or two hours. This is a necessary precaution for, if a very great quantity of fluid is used, there are naturally some possibilities of pulmonary edema and, curiously enough, certain spots on the back and buttocks often develop, looking like bruises. This is due to the anesthetic fluid settling in the loose fatty tissue of the most dependent portion of the body. Occasionally the patient will have a chill such as occurs when saline infusion is given to combat shock. This condition quickly subsides, particularly if hot water bags are placed about patient. It is a curious fact that this phenomenon will occur when solutions ten degrees higher than the bodily temperature are introduced into the circulation. The employment of ether in this way seems almost devoid of danger from either immediate or remote complications and represents the basic type of intravenous anesthesia, from which have grown many modifications.

We have experimented with a considerable number of drugs, either alone or in combination in the same solution with ether. The combination of drugs having distinct hypnotic properties, in the same solution with ether, seems to produce a very smooth, even and satisfactory narcosis, which could be maintained with a smaller amount of fluid than when ether alone was used. Paraldehyde and ether gave splendid results, deep anesthesia being produced almost as quickly as with hedonal, but we have practically discontinued its use for the reason that, as it is very rapidly eliminated from the lungs, the
vapor seems to produce a decided irritation of the larynx on certain individuals, particularly to those addicted to alcohol, and a crowing, croupy, spasmodic respiration due to spasm often supervenes at about the close of a moderately long operation. This condition would not banish it from our armamentarium were it not for the fact that the employment of mixtures containing paraldehyde were the ones that produced blood changes worthy of note. Hedonal 0.75 per cent. and ether 5 per cent. makes an admirable combination but such satisfactory results, with a different drug and slightly altered technic, were obtained, that it may be said to be the last word on the subject. Attached to the side of the reservoir usually employed, there is a secondary salvarsan tube of about 350 c.c. capacity. Rubber tubing from the two glass receptacles are attached to the divergent arms of a glass Y and the tube, which is connected with the indicator and cannula, is attached to the remaining free arm. A haemostat is clamped upon the tubes leading from both vessels. Into the smaller is poured 250 c.c. of a one and one-half per cent. of isopral in Ringer's solution, and into the other 2000 c.c. of a 5 per cent. solution of ether. The vein being exposed and opened, the haemostat is removed from the tubing leading from the smaller vessel containing the isopral solution, the cannula is inserted into the vein and fluid is allowed to flow very slowly so that it will take between four or five minutes for that quantity to enter the circulation, according to the tolerance of the patient; complete anaesthesia is induced with a greater or less amount of the solution but almost invariably it is accomplished with the entire amount, the condition and resistance of the patient notwithstanding. Before the entire quantity has entered the vein, the haemostat again is clamped on the branch tubing and that from the one leading from ether solution simultaneously removed, so that complete anaesthesia being induced, it is continued with ether. This same technic can be applied to hedonal in the same way, only using a 0.75 per cent. solution. Intravenous anesthesia induced in this way is very satisfactory, safe and reliable; the drugs used in the way described seem to have almost a synergis-
INTRAVENOUS ANESTHESIA.

The important part of the procedure is to give hypnotic solution very slowly until anesthesia is induced, immediately this is accomplished, stop its administration and advance the ether mixture. The narcosis is probably better and certainly more safely produced in this manner, and may be continued and maintained with the expenditure of less fluid than by any of the other methods referred to and it may be said that, at the present state of development, it is easily the method of choice.

Blood Changes.—In every case it was found that ether raised the blood-pressure from 2 to 24 mm., this rise being followed by a fall of 2 to 20 mm. in from one to three hours and then gradually returned approximately to the point observed before operation.

Hedonal invariably lowered the blood-pressure from 6 to 25 mm. of mercury, paraldehyde in about the same proportion, so also isopral. When mixtures were used, such as hedonal and ether, paraldehyde, or isopral and ether, the blood-pressure was influenced to the extent of being about the same as before the operation, as only a small quantity of the hypnotics was used in the anaesthetic mixtures. They, however, in every instance prevented the increased pressure noted when ether-scopolamine-morphine combination was used. It was singularly noted that female patients showed little or no change in the blood pictures, neither did males in operations of short duration. Alcoholic habitues naturally required more anaesthetic and, in one case, in which anesthesia was accomplished with a 5 per cent. solution of paraldehyde in normal saline, there was decided crenation of red cells with some clumping crenation, and some crenation was noted when a mixture of ether 3 per cent. and paraldehyde 2½ per cent. was employed. Some crenation was also noticed in one case where a large quantity (3500 c.c.) of 7 per cent. ether in normal saline was used. In every case the blood picture returned to normal in about four hours.

Hæmoglobin, estimated by Tallquist scale, showed an average diminution of 5 per cent. There seemed to be no changes
either in appearance or number of the leucocytes, and where an actual leucocytosis was observed before the infusion was given, the blood picture was practically unchanged. The erythrocytes were not materially affected except in three cases in which narcosis had been produced by paraldehyde.

Urinary Examination.—The urinary analysis made before the operation and for three or four days afterward showed no marked differences in the specimens. The total amount was increased and specific gravity lowered during the first twenty-four hours; often the specific gravity and solid content of the urine remained unchanged. In no case, even after employing 7½ per cent. ether solution, did blood, albumen or casts appear in the urine, though German observers did report occasional cases of transient haemoglobinuria after the use of the stronger ether mixtures. It was quite surprising that there was not a large urinary output after the infusion of large quantities of fluid, so much so that the patients were regularly catheterized, thinking perhaps there might be some vesical paresis from over-distention, but we failed to find at any time a urinary output in proportion to the amount of fluid introduced into the circulation.
NITROUS OXIDE AND OXYGEN NARCOSIS.*

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The object of this paper is a plea for a better selection of cases and more accuracy in administration in the use of nitrous oxide and oxygen for prolonged anaesthesia.

Most anæsthetists agree that aside from its well-known contra-indications, nitrous oxide and oxygen does not meet the requirements of every case of anaesthesia. Also many cases that apparently respond to the effects of this agent most beautifully are subject to greater risk than those that do not.

In most cases in which nitrous oxide and oxygen is used, as we approach the use of 15 per cent. oxygen with the nitrous oxide, we find that we fail to get complete anaesthesia; and as this is below the normal oxygen supply, nitrous oxide and oxygen anaesthesia is complicated with oxygen limitation. And since the principal problem to be solved in nitrous oxide and oxygen anaesthesia is the oxygen supply, any condition which to any extent hampers the oxygen reaching the ultimate tissues of the body is a contra-indication for its use. This may be, first, a mechanical obstruction to the respiratory passageways, second, inadequate lung capacity in proportion to the body weight, third, anaemia, or, fourth, toxic conditions in which the haemoglobin has to an extent combined with certain toxines, which limit the extent of its combination with oxygen.

Mechanical obstructions of the respiratory passageway as contra-indications for the administration of nitrous oxide and oxygen are well known.

A condition which we cannot regard as strictly abnormal but which is a contra-indication for nitrous oxide and oxygen, is that condition usually found in muscular and plethoric people.

* Read before the American Association of Anæsthetists, June 18, 1913.
and sometimes in others in which the lung capacity is small in proportion to the weight of the individual. Diseased conditions in which lung tissue has been destroyed or in which the excursions of the lungs are diminished by empyema, adhesions, or by pressure on the diaphragm, are the same in effect as regards nitrous oxide and oxygen. In these cases the lungs and the haemoglobin are called upon to functionate more actively in order to furnish the necessary amount of oxygen, usually resulting in an inefficient respiratory exchange and, because of this, these individuals will stand less limitation of oxygen, and nitrous oxide and oxygen should be used with caution or not at all.

Although anæmic individuals respond quickly and easily to nitrous oxide and oxygen, its use is contra-indicated. In these cases the passageway may be unobstructed, the lung capacity sufficient and the body weight not excessive, but the haemoglobin is deficient to the extent that the oxygen supply to the tissues is impaired.

A similar condition in regard to nitrous oxide and oxygen is severe toxæmia. In these cases the amount of haemoglobin may not be deficient, but a portion of it may be combined with toxines leaving a deficient amount of serviceable haemoglobin, thus limiting the normal supply of oxygen to the tissues. The hurried respiration of toxæmic patients is an effort on the part of nature to get oxygen to the ultimate tissues and indicates, as does also the cyanosis, that a portion of the haemoglobin has united with toxic substances.

If conditions are such that nitrous oxide and oxygen is the only anesthetic that can be used in cases of toxæmia (and the same may be true of anæmia), the oxygen supply may be raised much higher than in other cases and the narcosis maintained may be very light, because a patient in a high degree of toxæmia enjoys a certain degree of analgesia, as we see exemplified by patients in toxic conditions declaring that they "feel better" as death approaches, which of course is coincident with less haemoglobin being available for oxygen combination.
Now bordering upon these cases in which nitrous oxide and oxygen should not be used, is a large class of individuals with whom the success of nitrous oxide and oxygen is wholly dependent upon the proper percentage of oxygen. Because of the preceding contra-indications existing to a greater or less extent and in various combinations, we may lay down a rule of more or less accuracy regarding the percentage of oxygen to be used with the nitrous oxide in some such manner as follows: The percentage of oxygen required with the nitrous oxide is to the respiratory exchange as the weight of the body is to the lung capacity.

Experience has taught us that a patient that is anaemic to the extent of 50 per cent. haemoglobin, requires 20 per cent., or nearly 20 per cent., of oxygen with the nitrous oxide and since a normal individual can get along nicely with 10 per cent. oxygen or even less, it would seem that 50 per cent. of anaemia reduces the haemoglobin oxygen carrying capacity about one-half. But the respiratory exchange when deficient from anaemia does not effect the required oxygen supply with nitrous oxide in arithmetical progression. If the anaemia is less marked, still greater limitation of oxygen in proportion may be used. As an example: An individual of normal build and haemoglobin of 60 would require only 12 to 14 per cent. oxygen instead of 14 to 16 per cent. as we would expect from the above. This is probably because a haemoglobin percentage of less than 100 provides for normal respiratory exchange with most individuals, and also because a very low percentage of haemoglobin (15 or 20 per cent.) would cause cessation of functionation and be the same in effect as zero or no haemoglobin at all.

An example in regard to toxæmia: Suppose a patient is toxic to the extent that the respiration is increased to 35 to 40 per minute in order to maintain an efficient respiratory exchange which would give about double the normal air supply, then it would be logical to administer 20 per cent. of oxygen with the nitrous oxide, and practically this seems to work out about right.
As an example in regard to lung capacity: Suppose an individual developed normally to maturity and weighed 150 lbs. Then after a few years his weight increased to 180 lbs. or one-fifth more. Instead of a 2 per cent. increase of oxygen this patient should have a 3 or 4 per cent. increase. A reason for this may be that the requirements for oxygen are somewhat greater in proportion than the increase of weight because a relative delinquency exists not only of the lungs but of the heart and other organs as well. The later in life the patient has taken on the additional weight, the more evident will be the inadequacy of pulmonary functionation.

As a child develops its lung capacity becomes greater in proportion to its body weight. Therefore the younger the child the less efficient is the respiratory exchange, and other things being equal, the greater is the contra-indication for nitrous oxide and oxygen, and if nitrous oxide and oxygen is used, the greater should be the oxygen percentage with the nitrous oxide; thus a child of four or five will require nearly or fully 20 per cent. of oxygen with the nitrous oxide and it may run as high as 25 to 30 per cent., or even higher, in prolonged anesthesia. Therefore, because of this disproportionment between lung capacity and body weight in children, it is not advisable to use nitrous oxide and oxygen for prolonged anesthesia, and if used as a preliminary to ether, it should be only to the point of moderate or light narcosis and of short duration.

The reason, although seldom analyzed, that chloroform is a popular anaesthesia for children in spite of the fact that chloroform is more dangerous for children than adults, is principally due to the fact that they cry less when the administration is begun. Most of the crying can be prevented by beginning with a little nitrous oxide, not enough to produce any cyanosis or complete anaesthesia, and following it immediately with ether. This is done by using the foot pump connected to the nitrous oxide-oxygen-ether apparatus and to a perforated rim mask by means of a rubber tube, holding a towel around and over the mask while the nitrous oxide is given. If
the surgery is for tonsils or adenoids, it is easy to change the rubber tube from the mask to the mouth gag after etherization.

Nitrous oxide and oxygen should not in any case be used as a preliminary to ether, if any of the contra-indications exist which would make the use of nitrous oxide and oxygen inadvisable for use for prolonged anaesthesia.

It sometimes happens in the administration of nitrous oxide and oxygen that the patient, especially if he has not become frightened, will enjoy analgesia without anaesthesia and will completely relax and permit extensive operations in this condition. Or patients may merge from a state of anaesthesia to that of analgesia without any struggling or rigidity, at times during an operation if the administration is uneven or if there is an air leakage. At these times the patient has control of the rate and depth of the respiration and may either for amusement or for the purpose of attracting attention or self-adulation, purposely "hold their breath" or breathe very fast, so for this reason I believe that advice to the patient in regard to the breathing before beginning the anaesthesia, is of value. There can be no doubt that Hewitt's advice of a breath of air every three to five minutes with the nitrous oxide and oxygen, is of very great importance in preventing respiratory difficulties. I believe it is seldom if ever necessary to give nitrous oxide to the extent that secondary dilatation of the pupil occurs any more than it is necessary to push ether until the patient goes into the fourth stage.

The cyanosis resulting from the administration of nitrous oxide with deficient oxygen is due to a lack of opportunity for the blood to absorb the required amount of oxygen and not to an abnormal condition of the circulatory or nervous system. It disappears quickly when air or oxygen is added and although this condition should not be permitted to occur, it is probably no more dangerous than the cyanosis that accompanies a paroxysm of pertussis. But we may encounter another type of cyanosis which is entirely different in character,—it usually comes on slowly, is preceded by a marked interval of ashy
pallor, is not accompanied by rigidity, disappears slowly even though pure oxygen is given, and is indicative of a loss of vaso-motor tonicity or impaired heart action and is often followed by cessation of the respiration. I have seen this condition two or three times in very anaemic individuals, and while none of them died it certainly was most alarming.

Rebreathing is a means of considerable economy in prolonged nitrous oxide and oxygen anaesthesia. It is also of decided value for its stimulating effect on the respiration if at any time it becomes slow or shallow. But the amount of rebreathing used should vary but little, that is, it should be more or less constant. It is inadvisable to change suddenly from fresh gases to a large amount of rebreathing or vice versa, because it produces a sudden change of tension of both carbon dioxide and oxygen in the blood.

The apparatus I use is so constructed that rebreathing may be entirely avoided or used constantly to any extent desired. Rebreathing is accomplished by means of a rebreathing bag made of dipped rubber about the weight of a medium-weight surgeon’s glove and holds about 1000 c.c.—the most that a patient is likely to respire. It is attached to the face piece, and the inspiratory rubber valve which is between the rebreathing bag and the inhaling tube, makes it impossible for the exhalation to pass back into the inhaling tube, apparatus or gas bag, which could not be sterilized if contaminated by the patient’s respiration. The entire face piece together with the rebreathing bag, may be thrown into boiling water and sterilized without injury. The face piece is provided with two thin pliable rubber valves which offer no appreciable resistance even when wet because of their ability to loosen themselves from their seat at various points of contact instead of the necessity of every point of contact being loosened at the same time as is the case of solid valves.

The inspiratory rubber valve should be of thin dental rubber dam which will respond very easily to the inhalation. The expiratory (outside) rubber valve should be considerably heavier
and offer more resistance. This will cause a constant reserve in the rebreathing bag while it is being used, which will permit all the inhalation being a homogeneous mixture with rebreathed air. Otherwise the rebreathing bag will become empty the latter portion of each inhalation, causing a change during each inhalation from rebreathed gases in the rebreathing bag to fresh gases from the apparatus, alternating the composition and temperature of the inhalation suddenly during each respiration.

When the slot of the rebreathing bag is open full, the patient will rebreathe completely and it is easy to estimate with fair accuracy the depth of respiration and to adjust the rebreathing slot to use one-fourth, one-half or three-fourths or any portion of rebreathing desired. A constant amount of rebreathing employed, permits the use of a small rebreathing bag which is cheaply replaced when necessary.

One-fourth rebreathing does not call for any appreciable increase in the oxygen percentage; with approximately one-half rebreathing one or two per cent. more oxygen should be added; and when the patient is rebreathing approximately three-fourths, from three to five additional per cent. of oxygen should be added.

As a preliminary to ether I believe nitrous oxide and oxygen has no equal. Since by mixing oxygen in the proper proportions with nitrous oxide, complete narcosis can be maintained indefinitely, it may be used sufficiently long (three to five minutes, occasionally longer) to permit the ether to be administered gradually and slowly until complete ether narcosis is established. As the nitrous oxide and oxygen is continued until complete ether narcosis is established, there is then no return of the reflexes when air is substituted and consequently no swallowing of ether-laden secretions. The swallowing of ether-laden secretions is in all probability responsible for most of the early nausea and vomiting following ether narcosis. If nitrous oxide is used alone without oxygen preliminary to ether, the nitrous oxide administration must be of short duration because of the asphyxiation which would otherwise follow.
This makes it necessary to overwhelm the patient with ether and even then, the patient will almost invariably come out between the gas and ether narcosis to the extent that swallowing will occur about as much as if gas had not been given and the nausea and vomiting follow in about the usual percentage of cases.

The variation of oxygen percentages which may be used successfully with nitrous oxide and oxygen in prolonged anaesthesia is usually about three per cent. Less than this the patient becomes cyanosed and with more than this, partially "comes out." Therefore, to obtain the best results, it is a decided advantage and, unless the anaesthetist is skilful, it is necessary that the apparatus provide means for accurately measuring the oxygen dosage. Also with patients of unusual type or in unusual conditions, the judgment of the anaesthetist in using certain known percentages of oxygen with the nitrous oxide according to the individual case, is of great value as explained heretofore.

The passage of the inhalation through the passageways and the several feet of inhaling tube of any apparatus warms the inhalation to a point close to that of the room temperature. Gases when passed through tubes, become the same temperature of the tubes surprisingly quick. In regard to the heating of the gases up to or above body temperature, it would be well to remark that by the time the gases have reached the alveoli of the lungs, they have become practically body temperature irrespective of their original temperature. It is an easy matter to overheat an inhalation. We are well aware of the inefficiency of air and the difficulty of satisfactory respiration when the thermometer is close to or above body temperature, and we cannot reasonably expect it to be more efficient to a patient under anaesthesia.

A few words in regard to the mechanical side of nitrous oxide and oxygen administration for prolonged anaesthesia would not be out of place. The workmanship on the apparatus should be such that every joint and connection is absolutely
NITROUS OXIDE AND OXYGEN NARCOSIS.

air-tight, so that it will not be necessary to use a positive pressure to prevent an ingress of air. It is better and almost necessary that the valves and connections are tapered and hand ground. A positive pressure is only necessary for the use of a nasal inhaler in dental work or occasionally for tonsils or adenoids in adults or to prevent the admittance of air through the valves and connections of a leaky apparatus. A measured administration of oxygen with the nitrous oxide is of little or no value with the nasal inhaler, because the nitrous oxide is always more or less mixed with air by a portion of the inhalation coming in through the open mouth; in fact, the use of oxygen with a nasal inhaler does not seem to be necessary at all, both because of the air ingress through the mouth and because a nasal inhaler is seldom used for any other purpose than obtaining analgesia. A positive pressure absolutely prevents the use of oxygen by percentages because it is a mechanical impossibility to adjust two reducing valves to give the same pressure, but the use of partially filled bags gives the same pressure (atmospheric pressure) in both nitrous oxide and oxygen bags and permits a measured dosage of the gases. An atmospheric or slightly negative pressure anesthesia, also uses far less nitrous oxide and oxygen than does a positive pressure and does not require a change of oxygen dosage with every variation of respiration. The nitrous oxide and oxygen bags should be large so that they will require but little attention to keep them partially filled.

Freezing of the cylinders is easily prevented by using reduced openings (one sixty-fourth or less of an inch in diameter) in long yoke nipples. They prevent a marked expansion of the gases until well into the cylinder arms where there is plenty of metal to take up sufficient heat to prevent freezing.

A mixing chamber is not only useless, but of decided detriment. The passageways and inhaling tube or even the pharynx of the patient is all that is necessary for a mixing chamber and anything more than this is merely a means of air contamination in the beginning, and later, of delaying the effects of a
change of dosage in reaching the patient. Neither should there be a valve of any kind in either the nitrous oxide or oxygen passageways back of the mixing valve, because such a valve interferes with the percentages used and is unnecessary when the rebreathing bag is attached to the face piece.

A bore of at least one inch in diameter for the tube and passageways is necessary to prevent the patient from complaining of the negative pressure. Nothing frightens a patient more than when the mask or inhaler is placed over his face to find that it is difficult for him to get a full and free inhalation.

Not every physician, no matter how complete his knowledge may be of the art and science of anaesthesia, can become adept in the use of nitrous oxide and oxygen. A man to use nitrous oxide and oxygen successfully, must be a man that not only possesses the required knowledge, but must possess it sufficiently well that it becomes almost reflex with him. He must not be a phlegmatic sort of an individual, but quick and alert. The untoward symptoms of nitrous oxide and oxygen are so variable and change with such rapidity that he must be able to almost anticipate any one of them before it occurs.

The extent and distribution of the use of nitrous oxide and oxygen for surgical anaesthesia is practically the same as the numbers and distribution of skilled anesthetists. Those anesthetists who have no disposition to acquire the skill and technical knowledge necessary for the proper selection of cases and the successful prolonged administration of nitrous oxide and oxygen, are, for the most part, not favorably inclined toward its use. This is perhaps fortunate both from a humanitarian stand-point and because its use by them would soon discredit this highly valuable anaesthetic agent.

In conclusion I wish to say that if I have succeeded in adding another protest against the indiscriminate use of nitrous oxide and oxygen and against the disposition on the part of many anesthetists to ignore some of the more important refinements of nitrous oxide and oxygen narcosis, I will feel I have accomplished something.
INTRATRACHEAL ANÆSTHESIA.*

A. BY NITROUS OXIDE AND OXYGEN.
B. BY NITROUS OXIDE AND OXYGEN UNDER CONDITIONS OF DIFFERENTIAL PRESSURE.

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A. THE introduction of intratracheal anæsthetization by ether immediately suggested the desirability of using nitrous oxide and oxygen by the same method.

Much evidence exists that surgery may be made more successful by the more general use of nitrous oxide anæsthesia. Both nitrous oxide and intratracheal anæsthesia have acknowledged advantages, and it becomes, therefore, a matter of importance to combine the good features of each.

Cotton, Boothby, Gwathmey and others have successfully kept patients under surgical anæsthesia by nitrous oxide, after a preliminary etherization, by simply allowing the mixed nitrous oxide and oxygen to stream in through the intratracheal catheter in the same manner that ether vapor is given intratracheally.

Such a method is wasteful of the anæsthetic, which under these conditions must be supplied in such excess that, at each inspiration by the patient, there is a very little dilution of the anæsthetic within the trachea by air which, otherwise, would be drawn through the larynx around the intratracheal catheter. There must, in other words, be such a supply of nitrous oxide, that only a minimum amount of air is drawn in around the intratracheal catheter during inspiration. To supply such an excess of anæsthetic is not perhaps objectionable when ether is used, as ether is cheap in comparison to nitrous oxide, and further it is a comparatively easy matter to secure a sufficient degree of concentration of ether vapor

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to anæsthetize satisfactorily a patient by the usual intratracheal technic. Moreover, the escape of the air around the tube during the intratracheal anæsthesia by ether has been encouraged for the purpose of preventing the inhalation of blood and mucus during intra-oral operations.

Nevertheless, during ether anæsthesia the escape of large quantities of ether in the room is at least unpleasant, even if the waste of the ether is not considered a matter of importance.

In order to overcome these difficulties, in connection with anæsthesia by nitrous oxide, the writer has devised the little bag illustrated in Fig. 1. It is tubular in shape possessing a double wall so that it is capable of distention whether fitted over the catheter or not. It is pulled over the latter to a short distance above its extremity, and after the catheter is inserted into the trachea, the bag is distended with air through the fine rubber tube attached to it, thus effectually closing the space between the outside of the catheter and tracheal walls. The patient may now breathe in and out through the intratracheal catheter, and when the external end of the latter is attached to a respiration bag, receive the nitrous oxide and oxygen directly from the tanks undiluted with air.

Fig. 2 represents the arrangement of the various parts of the apparatus used for intratracheal anæsthetization by nitrous oxide and oxygen according to this method. (4) is a reducing valve, the legs of which are detachable so that everything necessary for this method of anæsthesia can easily be carried in a small bag.

The tank is attached to the reducing valve, as illustrated, and because of the latter, a regular flow of the gas passes to the wash bottle (3) through the tube (2). Into the same bottle, upon the opposite side of a central partition the oxygen enters through the tube (8).

The purpose of the wash bottle is to furnish a visual method of estimating the flow of the gases. We are perfecting a more exact method of measuring the gases. By means of the third tube the mixed gases are conveyed to the respiratory bag (6). This bag must never be allowed to become completely filled and, in order to guard against distention, it is wise to insert a safety valve between it and the wash bottle. The respiratory bag is attached by its opposite end to a cylindrical valve. The latter is made of two cylinders, the external one of which possesses three openings upon one side (A, E, D) the intake side, and one (C) opening upon the opposite side, to which the tube passing to the intratracheal cannula (7) is attached.

The openings through the inner cylinder are so arranged that as it is rotated, one of the three openings (A, E, D) entering the cylinder upon one side, may be thrown into communication with the single opening (C) emerging upon the opposite side.

According as opening D, E, or A is placed in communication with the tube C emerging from the cylinder, the patient inhales, from the respiration bag and exhales through B into the external air or rebreathes back
Intratracheal catheter surrounded by distensible rubber bag for occluding the trachea.

Arrangement for apparatus for intratracheal anesthesia by nitrous oxide and oxygen. 1, oxygen tank; 2, rubber tube conveying nitrous oxide from the reducing valve (4) to the wash bottle (3); 5, nitrous oxide tank; 8, rubber tube conveying oxygen from the oxygen tank (1) to the wash bottle (3); 6, respiration bag; 7, intratracheal catheter. A, B, C, D, and E, openings in valve controlling the amount of rebreathing.
FIG. 3.

Speculum for catheterizing the trachea: 1, lamp; 2, spring which closes the circuit in the dry cells contained in handle (3).

FIG. 4.

Arrangements for apparatus for nitrous oxide anesthesia under conditions of positive pressure. 1, valve controlling amount of rebreathing; 2, aluminum box containing respiration bag; 3 and 4, tambours controlling the position of valves which permits of rise and fall of pressure within the box (2); 5, nitrous oxide tank and reducing valve; 6, motor; 7, spring controlling height of pressure within box (2).
Arrangements for spring, tambours, and valves attached to the end of aluminum box described in Fig. 4. 1, rebreathing valve; 2, aluminum box; 3 and 5, tambours controlling position of valves; 4, spring controlling height of pressure within box; 6, nitrous tank with reducing valve attached; 7, wash bottle measuring the flow of nitrous oxide and oxygen.
and forth from the inhalation bag or may breathe pure air. In occasional cases, in which a more profound anesthesia may be needed for short intervals, the action of the nitrous oxide may be intensified or pieced out by dropping a few drops of ether into the cylinder. Provision is also made by means of a little electric heater within the cylinders for rapid volatilization of the ether and the prevention of the condensation of moisture on the mica valves.

One-quarter of a grain of morphine and one-hundredth of a grain of atropine are administered one hour before the operation. Better than morphine is narcophine, which has given greater satisfaction.

The back of the tongue is touched with 10 per cent. cocaine. The patient is then anæsthetized, preferably by chloroform, in the usual manner and the catheter inserted into the trachea. This may be accomplished by means of the Jackson direct laryngoscope so modified that it is deficient at the side in a manner permitting of the withdrawal of the instrument without the necessity of pushing the catheter through it. By the use of such an instrument it is possible to insert the catheter without thereafter detaching it from the tubing connecting it with the gas bag.

The speculum represented in Fig. 3 is a convenient instrument for catheterizing the trachea. The curve is just enough to still permit of the direct view of the larynx and yet to direct the distal end of the catheter forward into the larynx. The lamp of this speculum is illuminated by dry cells contained in its handle.

After the tube has been inserted into the trachea, its external end is attached to the outlet tube of the three way valve which has been previously attached to the stand. The little rubber bag around the trachea is distended and the anesthesia will now proceed uninterruptedly with nitrous oxide and oxygen alone and will give efficient relaxation in the normal individual for all the usual abdominal or mouth operations.

The rubber bag distended around the catheter, prevents the inhalation of blood and mucus into the trachea and in no way adds to the danger of the procedure, as the pressure of the gases can never exceed that in the inhalation bag. Two provisions prevent the gases in the bag from rising above the
atmospheric pressure. First, the safety valve introduced between the respiration bag and the mixing bottle. Second, the respiration bag itself, which cannot become overextended without its being noticed by the anaesthetizer.

Rebreathing is an important feature of this method of anaesthesia—all that remains for the anaesthetizer to do after the intratracheal catheter has once been introduced into the trachea, is to turn the three way valve back and forth between the breathing tube (E) and the tube (D) as the respiration bag empties and fills. About one-half the time the average patient is rebreathing.

The dimensions of the catheter are important. It must have a lumen of at least $\frac{5}{16}$ inch. The author has used a very thin-walled, flexible metal tube covered with a piece of Penrose drainage tube.

Further experience with this method has demonstrated that care to avoid traumatism during the insertion of the catheter is necessary; and moreover that even though nitrous oxide alone be used as the anaesthetic it is possible for the anaesthesia to be complicated by pneumonia in those cases in which this complication is to be feared.

Nevertheless in properly selected cases this method of anaesthesia is a useful one.

B. BY NITROUS OXIDE AND OXYGEN UNDER CONDITIONS OF DIFFERENTIAL PRESSURE.

It will be appreciated that successful anaesthesia by the method previously outlined depends entirely upon active respiration by the patient. It is for this reason that narcophin, which exhibits a much less toxic effect upon the respiratory centre than morphine, has been found so valuable as a preliminary narcotic and that it is advised to give atropin if a preparatory injection of morphine is depended upon.

If the pleural cavity is opened and active respiration is rendered impossible, the lungs will be unable to fill and empty themselves with the gases during inspiration and expiration. In order to permit of passive inflation and deflation of the lungs with nitrous oxide and oxygen when the chest has been opened
and also without that extravagant waste of the gases which is incidental to true intratracheal insufflation, provision has been made for exerting an alternating increase and decrease of pressure upon the outside of respiration bag described in this paper.

The arrangement adopted to produce this effect has been perfected in conjunction with the catheter and special devise for obstructing the trachea described in this article though it may be used in connection with a simple face mask. It provides for true artificial respiration synchronously with the patient's respiration, in other words, merely accentuating the patient's efforts of respiration.

The gases are forced in and out of the respiration bag by the alternating pressure upon it with provision for any desired amount of rebreathing as though the patient were doing his own breathing.

Actually, inspiration alone is assisted. Provision has been made for the loss of that amount of expired air in the passage back to the respiration bag which it may be necessary to replace from the gas tanks.

These results are accomplished by inclosing the respiration bag in an air-tight aluminum box, Figs. 4 and 5 (2).

By means of the attachment at one end of the box of which the important parts are four valves, a spring and two flaccid rubber tambours (3 and 5), air from the insufflation apparatus is allowed to pass alternately into the space around the bag within the box and outside the box into the room. When the air passes into the box it increases the pressure around the respiration bag which contains the nitrous oxide and oxygen. This increase of pressure is transmitted to the gases within the bag so that they are forced into the patient's lungs. It must be borne in mind that there is, of course, no communication between the interior of the respiration bag and the space enclosed outside of the rubber bag by the aluminum box. When the pressure within the box reaches a certain height for which the spring (4) may be set the air blows out the rubber tambour and reverses the position of the four valves. This reversal of the valves occurs suddenly, inasmuch as the rubber diaphragm cannot start its movement until the resistance of the spring is overcome; again the resistance offered by the spring is greatest at the extreme positions of its swing. In the reverse position of the valves the current of air from the machine no longer enters the box, but exhausts in part into the room and in part into the space enclosed by the second tambour. The stop-cock controls the amount of air acting on this tambour and, consequently, the time when the membrane of this tambour blows out, changing the valves.
back to their original position. It will be appreciated that the speed with which the position of the valves is changed back to their original position depends only in part upon the second tambour. If a minus pressure suddenly occurs within the aluminum box, this will tend to suck in the first tambour which of itself tends to change the position of the valves back to the first position permitting the entrance of air into the box. Because of this fact there is a strong tendency for the increase and decrease of pressure within the box to be synchronous with respiration.

The synchronism of the movement of the valves with respiration depends upon the fact that the changes in the pressure of the gases within the rubber bag transmit themselves to the space outside the bag and within the aluminum box and so to the rubber tambour. The piece (1) is a valve permitting of the loss of any desired amount of the gases exhaled from the patient's lungs. It permits, in other words, of any desired amount of rebreathing from no rebreathing up to complete rebreathing of the expired air. We have therefore, in this apparatus a means of true artificial respiration with whatever gas (either air or nitrous oxide and oxygen) that is allowed to fill the respiration bag.

Should it be desired at any moment to change from nitrous oxide to pure air, respiring the patient with only the latter, this change may be accomplished by moving a slide valve, which immediately connects the intratracheal catheter with the space outside the respiration bag.

It is important to remember that the only manner in which a minus pressure may be produced within the box is by a sudden inspiratory effort by the patient. While there is provision for artificial suction of the air out of the aluminum box yet the mechanism by which the valves are changed from the position permitting of expiration by the patient to that of inspiration is not accomplished by artificial suction. Particularly when the chest wall is open if during artificial respiration the expiratory phase depends upon an artificial suction a complete collapse of the lungs will result. This complete collapse combined with the replacement of the negative intrathoracic pressure during inspiration with a positive pressure which compresses the pulmonary vessels will so obstruct the pulmonary circulation that death will result in a little while.

For this reason the author believes that the principle of an extensively advertised machine for artificial respiration certainly when the chest is opened is a wrong one. It is much better to depend upon the elasticity of the lungs even when the
intratracheal anæsthesia.

The chest is closed for expiration, except in rare intervals and then only for a few respirations.

During artificial respiration with the chest wall open as in thoracic surgery, it is absolutely necessary to depend alone upon the elasticity of the lungs for expiration and to absolutely avoid artificial suction.

The above described apparatus may be used with the intratracheal catheter provided with the little rubber occluding bag described in this article.

It may, however, be used in connection with a tightly fitting mask and therefore without the intratracheal catheter. When used with a mask it is better to provide the mask with an elastic band which passes around the head and by which it is tightly held over the mouth and nose.

Used in either manner, the apparatus furnishes a method of administering nitrous oxide and oxygen by true artificial respiration in a manner which will be synchronous with any of the more forcible respiratory efforts of the patient.

It will simply accentuate the voluntary efforts of inspiration and expiration. It increases the safety of nitrous oxide anesthesia and for two reasons its efficiency. The first reason is that it administers the gas under conditions of increased pressure. The second is that morphine may be used with greater freedom with it. The preliminary injection of morphine has been always viewed as almost a necessary adjunct to the best nitrous oxide anesthesia. Unfortunately morphine diminishes the respiratory movements to a marked degree and with them the power of the patient to inhale regularly the gas. This disadvantage, however, is not noticed if the gas may be introduced under conditions of differential pressure. The safety of nitrous oxide anesthesia is increased because failure of respiration cannot take place, and may at once be relieved by respiration with air.

The slide valve described ensures against the possibility of excessive pressure within the lungs. Its exhaust opening is simply closed on inspiration, being guarded by a piece of mica which raises upon the slightest expiratory effort. During inspiration the spring never allows the pressure within the respiration box to exceed 10 mm. of Hg.
DEATHS FROM ANÆSTHESIA

AND LESSONS TO BE DRAWN FROM THEM.*

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In this paper I shall not try to come to final conclusions, for even in the single case, imperfectly observed in the emergency, it is often hard to interpret just what happened.

First, however, one thing is clear. The fact that I or any surgeon can report ten deaths and three close approaches to death from anaesthesia personally observed in the course of two or three years is of itself evidence that the old delusion of the safety of anaesthesia can no longer be maintained.

It has been maintained in the past by charging off to shock, heart failure, intercurrent pneumonia, alcoholism, etc., the great majority of cases that we ought not honestly regard as due to anything but anaesthesia.

Perhaps the propriety of classifying some of my list of cases as anaesthetic deaths may be brought in question—all I can say is that if they had not been anaesthetized the trouble would not have occurred.

First, as to the pneumonias, I have here cited two cases only. At least one other case, recent, died of post-operative lobar pneumonia but following an interval of a few days and preceded by delirium tremens, and at least two others of slow bronchopneumonic processes following ether.

The two I have selected for mention are as follows:

The first case was that of a young man of twenty-four, a fine specimen physically, who had an acute attack of catarrhal appendicitis. The operation itself was short and uneventful. He "took ether badly," but nothing in particular happened. The next day he showed temperature and bronchitis. The second morning he had a well-defined lobar pneumonia of the right

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lower lobes, unable to cough without excruciating pain in the wound. After three days he died of toxæmia, but also worn out by the pain of the excruciating, uncontrollable cough.

The second case was in a man of fifty, operated on for gallstones, an ordinary type operation. He too "took ether badly" and was not in good condition by any means at the close of proceedings. Next day he developed a bronchopneumonia, confluent at the bases, and on the third day after operation died.

Now as to the moral, to my mind it is clear enough. In the hospital in which these cases occurred as in many others there is too much work for the professional anaesthetists to do and many "routine" cases are anaesthetized by junior house-officers. Now these house-officers seem convinced with rare exceptions that if a patient isn't dead—if he is breathing—that that is enough.

Here is where the trouble comes.

Until the etherizer realizes the danger of letting the half-choked patient suck in air and mucus; until he realizes that nothing short of an approximately normal, quiet, unobstructed respiration is good enough—until then, we shall have ether pneumonias occasionally, or more than occasionally, according to the run of the luck and the run of the cases.

We ought to have none but really skilled anaesthetists. This is not yet possible, but we must keep hammering at the kind of anaesthetists we have.

The next case was a girl of six, anaesthetized for me by the family doctor for removal of a needle imbedded in the leg. Save for a slight bronchitis she seemed in perfect health. The day after I was called out of town and only heard the history on my return. The ether recovery had been abnormally slow, with considerable nausea, the child seemed stupid and the next day diarrhea developed. The condition remained much the same for three days, without temperature, when she suddenly grew worse and her heart went to pieces, the "enteritis" continuing; a fatal result ensued on the fourth day.

The picture to my mind is one of acid intoxication, though this view is not supported by any tests made on the case.
Recently, I have had a like case in which I believe failure to recognize and treat acidosis would have lost the case.

Especially with children we must bear this post-operative or post-anæsthetic complication in mind. Often, no doubt, it is not important if present, but it is well to bear it in mind, and in case of doubt sodic bicarbonate and early feeding by mouth or rectum is harmless and may change the issue entirely.

One death I have seen seemed to be purely from ether poison, presumably from impurities. The patient was an elderly woman, operated on for hernia, who died on the second day, stupid and with a subicteric color. Tests for acid or other metabolic intoxication were negative. Within a week or two of this case there were two other like cases that got well. One of them, a case of my own, showed the skin-color, the slow pulse and hebetude that have been attributed in chloroform poisoning to liver degeneration, chemically induced. At this time I found a cheap brand of ether had been run in on us. I do not know that this was responsible, but after we got back to our usual supply no more cases developed.

The moral of this is that the excellent work Baskerville has been doing for New York ought in some way to be made available for all of us, and we ought not to be asked to give poison to better the superintendent's expense account.

Two cases I have seen of chloroform poisoning; neither died, but both came close to death.

One, a young negro anæsthetized for a throat operation, stopped breathing before work began, and was resuscitated only by inversion; he did the same thing on a second trial at operation by another anæsthetist for another surgeon.

The second case was in a young man of twenty-eight, rather fat but vigorous and athletic who was being etherized by an experienced anæsthetist who had used anæsthol for the primary stage. Just as the patient was being wheeled in, ether had been substituted. I noted and spoke of the bad color: at that instant he stopped breathing, turned from blue to gray, and his pulse was barely perceptible. Inversion head down and a couple of minutes of artificial respiration restored him to a state justifying
further ether and the performance of the slight operation contemplated.

These cases represent the result of chloroform in too high a percentage. They help show why I bar absolutely any chloroform mixture as a preliminary, and why I stick to the Boston dislike of chloroform. At best, chloroform calls for very expert handling, and I see in practice few cases requiring its use.

Next comes a case of a man shot through the lung, diaphragm and abdomen. He took ether well enough till I was all done, then, as he began to come out, he breathed badly, coughed, choked, filled up with blood, and, in spite of my prompt tracheotomy, choked to death from flooding of the trachea. The death was from lung hemorrhage, superinduced by anesthesia. It was, however, probably unavoidable.

Next comes an inguinal hernia, two days strangulated, in a man of sixty-five, in poor shape. On coming out, after the operation, he began to vomit for the first time, and before anything could be done, died, choked to death by his own vomit. This was no fault of the etherizer, but I suspect I should not have been misled by the previous absence of vomiting, and should have used spinal or local anesthesia.

In another man, big, hearty, sixty, and alcoholic, I was going to fix an acromioclavicular luxation. As he went under the ether, I remarked to a passing colleague that this sort of short-necked, wheezy man ought really to be anæsthetized by the intratracheal method. I did not use it because the anæsthetist at hand was unskilled in its use. There was much trouble with breathing, much mucus, etc. The anæsthetist with my permission switched to chloroform with a little improvement only. Presently breathing stopped abruptly. Instantly I did tracheotomy. The patient then went all right, but later developed inhalation pneumonia and died after six days.

The moral is that all anæsthetists (and my man that time was a professional) should be trained to all methods of anæsthesia, not one or two.

There was a case of a frail young girl (seventeen years) to be operated on for tuberculous neck-glands. I saw the intratracheal introduction, saw the administration. Constantly
there was trouble with coughing, straining, and partial extrusion of the tube. It was not my case so I left some remarks behind and went away. Later I was told that the tube was removed and a cone substituted. Shock, hemorrhage and the continued strain brought about a fatal end that night.

So far as concerned the intratracheal part, it was simple. At no time did she have ether enough to lose even the edge of her laryngeal reflex.

The moral is that intratracheal work is for the man who knows how.

One case usually charged to gas-oxygen anesthesia and to shock, at the hospital—a plating of the femur that proved long, rough, and difficult—that led to the death of a vigorous middle-aged man under the picture of heart collapse sixteen hours after operation without any primary symptoms of shock or other trouble—this case I believe belongs to the fat-embolism series and has nothing to do with anesthesia except coincidence.

One case, to close—a death from local anesthesia. One of my colleagues did a Bassini for a hernia in an elderly patient, in poor general condition, under local anesthesia with cocaine and adrenalin solution, the routine mixture of the hospital. The tissues blanched excessively during the operation; next day they began to blacken; presently the gangrene became infective and death was from sepsis.

This means that while adrenalin as an adjuvant to cocaine is all right for mucous membranes, its use in the tissues is not without risk.

Now I present this haphazard list of cases and the also haphazard remarks, not with the notion of directly solving any problems, but to promote discussion. I still have my affection for the gas-oxygen-ether combination—still have seen no trouble from it. May I suggest that if we recognize and admit freely the troubles from ether, etc., as we ordinarily meet them, then go on to learn by full discussion the things to avoid, the possible dangers in handling gas-oxygen, intratracheal, and intrapharyngeal methods, and the more modern methods of handling intraspinal and extradural injections we shall presently be in fairly good position to lessen the accidents and the disagreeable incidents of anesthesia.
THE QUESTION OF ANÆSTHESIA IN GOITRE OPERATIONS.*

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INTRODUCTORY REMARKS.—The wonderful achievements which have marked the progress of surgery during the past few years finds an especially brilliant illustration in the domain of the operative treatment of goitre, from the radical or curative to the symptomatic or palliative procedures. On the basis of new discoveries along biological lines, or because of special refinements of technic, the surgery of the thyroid gland has reached a certain stage of perfection, with constantly improving results.

The question of anaesthesia in goitre operations, on the other hand, is still an unsettled problem, and is, therefore, in the forefront of surgical interest. The particular method of inducing insensibility to pain in these operations which is given the preference varies according to the personal experience or otherwise acquired opinion of the surgeon. The different procedures now in use have been employed with more or less success, but it would seem reasonable to assume that the most satisfactory results may be obtained by the method of anaesthesia or analgesia which is most nearly in keeping with the principles involved in the surgical treatment of goitre.

It is not my purpose in this contribution to do more than touch upon the technical side of thyroid surgery. I shall confine my brief consideration of the subject rather to such aspects as are directly concerned with the selection of the anaesthetic or the method of administration.

SURGICAL CONSIDERATIONS WHICH INFLUENCE THE SELECTION OF THE ANÆSTHETIC AGENT OR METHOD OF ADMINISTRATION.—Certain surgical problems, always to be reckoned with, are particularly important in the surgery of the thyroid gland, not only because of the location of the operative field, but because of the psychical aspects which may be

* Read before the American Association of Anæsthetists, June, 1913.
involved. These problems, which need only be mentioned here, are influenced more or less directly by the anaesthetic, and it is therefore of the utmost importance that they be given due consideration. Chief among them are the following: (1) The maintenance of normal blood-pressure; (2) the determination of the amount of dyspnæa; (3) the avoidance of injury to the recurrent laryngeal nerve, or other nerves in the vicinity; (4) the control of hemorrhage; (5) the lessening of post-operative shock; (6) the lessening of psychic shock.

Selection of Anæsthetic and Method of Administration.—The following general procedures enter into consideration in the selection of an anaesthetic agent or a method of administration for any operative procedure upon the thyroid gland: (1) General anaesthesia; (2) anoci association; (3) local anaesthesia; rectal anaesthesia (ether in oil).  

General Anaesthesia.—It is interesting to note that those whose practical work has been the most extensive are also those who are most strongly inclined toward methods of anaesthesia other than general narcosis. Kocher, with his enviable record of over 5,000 goitre operations, is unconditionally opposed to general anaesthesia in these cases. The disadvantages of general anaesthesia, according to Kocher, consist in the following:

(1) The danger of too much lowering of the blood-pressure when the heart action is weak. The falling of the blood-pressure below 120, as compared with the average of 150 mm. Hg., measured with the Riva-Rocci apparatus, endangers the outcome of the radical operation. Measuring the blood-pressure is one of the necessary preliminaries to any method of general anaesthesia in goitre operations.

(2) The difficulty of ascertaining the degree of dyspnæa.

1 Since the preparation of this paper Dr. James Tayloe Gwathmey, in a series of 50 general surgical cases, has employed a mixture of ether in oil, administered by rectum. The anaesthesia thus induced, according to this authority, has been almost ideal, simulating normal sleep. If further experience bears out these results, the method gives promise of being one of the best, if not the very best, for goitre cases. The writer is testing the method in a series of neck cases.
(3) The increased risk of accidental injury to the recurrent laryngeal nerve.

(4) The lessened surety of a perfectly aseptic course, for the dressings, and with them the wound itself, are more apt to become contaminated by vomited matter.

Another very serious objection against general anaesthesia in goitre operations is the patient's liability to a severe attack of asphyxia, in consequence of excitement at the beginning of the narcosis, more particularly in cases with stenosis of the trachea or paralytic symptoms on the part of the laryngeal nerves.

The condition of the heart and lungs undoubtedly adds to the risk of general narcosis in a considerable number of goitre cases. Grave risk is involved in aged goitre subjects, with much enlarged thyroids, softening of the trachea, chronic bronchitis, and irregular weakened heart action. General narcosis has also been held responsible for fatal syncope at the beginning of the operation, more or less sudden cardiovascular symptoms, bronchial disturbances, and pulmonary complications. The vomiting and retching after chloroform or ether anaesthesia are extremely distressing and painful, and may induce very troublesome complications, such as severe secondary hemorrhage. The administration of chloroform is sometimes followed by albuminuria, and its toxic action is apparently increased through degeneration of the thyroid gland. Post-operative complications of a toxic character after the employment of general anaesthesia are also referred to by Kocher, who attributes the very low mortality in his last series of one thousand goitre operations to the omission of the general anaesthetic.

Goitre operations under general narcosis expose the patient to the danger of nerve-contusion through ligatures or clamps, followed by spasm of the glottis, with secondary paralysis. It should also be emphasized that a paresis which has existed prior to the surgical interference may become aggravated into a total and persistent paralysis through traction incident to the operation under general anaesthesia.

The number of surgeons who persist in the belief that
there is a tendency to exaggerate the dangers of general narcosis in goitre operations will undoubtedly diminish on the basis of increasing practical evidence. It is certainly suggestive that authorities such as Kocher, Rehn, Socin, Jaboulay, and others, unconditionally oppose general narcosis in these cases. Their operative records bear eloquent testimony to the soundness of their views.

If, for any reason, general anaesthesia must be employed, the essence of orange-ether proposed by Gwathmey, or any other vapor anaesthesia, is the most satisfactory. Vapor anaesthesia, with the apparatus first proposed by Gwathmey, in 1910, provides for the giving of a smaller amount of the anaesthetic than is required with any other method. Excitement is usually absent or inconsiderable, and unpleasant after-effects are altogether absent in ninety per cent. of the cases. All patients can be narcotized within five minutes, and a satisfactory continued narcosis is always maintained. The addition of one to three drops of the oil of orange, or three to five drops of the essence of orange (25 per cent. oil of orange and 75 per cent. deodorized alcohol) serves to disguise the odor of the anaesthetic very efficiently, in this way diminishing the undesirable side effects incident to the inhalation of the gas, and approaching this method to the principle of Crile's anoci association.

Anoci Association.—The anoci association of Crile introduces new features into the aspect of anaesthesia, by taking into consideration the psychic side of the patient. The method consists in the injection of local anaesthetics into the field of operation, in addition to the other preparations, prior to the giving of the general anaesthetic. The procedure is based upon the observation that the psychic excitement of the goitre bearer is one of the greatest obstacles in the way of operative success. Observation of Crile's work is most interesting and cannot fail to impress the spectator with the desirability of utilizing the elements of anoci association in the operations under consideration. Crile claimed and showed that the general anaesthesia, more particularly with ether, fails to protect the brain cells against exhaustion from the operative traumatism. The shock incident to fear, the shrinking of the
The psychic factor, according to Crile, "which is the most important in the surgical risk, may be eliminated by 'stealing' the gland. When eliminated, the operative risk seems to be greatly reduced."

Local Anesthesia.—The advantages of local anesthesia in goitre operations were first emphasized by Socin, and his recommendations were endorsed by Bier, Madelung, and other operators of renown. Kocher, who is an earnest advocate of local anesthesia, is fortified in his position by an experience in a series of 5,000 goitre operations. Among 603 uncomplicated, but in part very difficult goitres, in his last series of 1,000 cases, no patient died. The same applies to 19 operations on recurrent goitres, which are apt to prove especially troublesome to the operator, on account of cicatrices and adhesions. Of 26 incisions for malignant struma, all recovered. Definite end results could be traced in only 320 of Kocher's operative cases, with a complete cure in 150 patients, while 148 are considerably improved although still showing individual symptoms of the disease. The results were unsatisfactory in only 22 cases, either because the operation could not be completed, or because recurrences followed (in five per cent.), or on account of secondary disturbances of thyroid origin failing to subside after operation.

The possible advantages of local anesthesia, in my experience, are the following:

1. The hemorrhage is considerably diminished.
2. A free survey of the field of operation is provided,
and movements of the throat at critical steps may be pre-
vented by instructing the patient to hold his breath.

(3) The inferior laryngeal nerve is absolutely protected,
by the possibility of phonation in the conscious patient. This
is doubly important in view of the fact that clamping or ligat-
tures in the immediate vicinity of the nerve may mean a per-
sistent hacking cough as a sequel to the operation.

(4) Requiring a better control of the technic on the part
of the operator, local anesthesia safeguards the patient against
all unnecessary brutalization of the tissues.

(5) The strain on the kidneys is lessened, as they are not
called upon to eliminate the general anaesthetic, and may be
flushed through the stomach, by the administration of abundant
fluid, when the need is greatest, immediately after the
operation.

(6) Avoidance of post-operative vomiting, and thereby
diminution of the risk of secondary hemorrhage.

(7) Less elaborate technic, as local anesthesia does not
involve the same refinement of detail as general narcosis.

(8) The risk of operative shock is partly eliminated, as
patients are apt to consider the operation less serious under
local than under general anaesthesia. The importance of this
is illustrated by the occurrence of death in patients while being
prepared for general anaesthesia, the fear of the operation
being intensified by the thought of “going to sleep.”

(9) Elimination of the dangers of all general anaesthetics.

In a recent paper on the surgery of the thyroid gland
(1913), Berry emphasizes that much depends upon the an-
esthetic and much upon the patient. In the opinion of this
operator, the method which is the most suitable of all, for
the severe type of case, is local anaesthesia, provided that the
patient is willing to submit to operation under these conditions.
The fact that the patient can drink freely during and im-
mediately after the operation, is regarded by him as the main
advantage of local analgesia, diminishing as it does the tend-
ency to excessive post-operative tachycardia, which is one of
the principal dangers after surgical manipulation upon goitres.
Exophthalmic goitre. Before operation.
Thyroidectomy—Injecting local anaesthetic, novocaine, 1 per cent. in skin; 1/4 per cent. in deeper structures.
Thyroidectomy under local anaesthesia. Goitre exposed and tumor dislocated from behind sternum and brought up into wound.
Thyreodectomy under local anesthesia. Goitre-holding forceps in place.
After extirpation of tumor.

Trypodoctomy under local anesthetics. Stopping ooze with hot applications to the raw surfaces.
Thyroideotomy under local anaesthesia. Deeper structures sutured. Skin ready for closing.
Fig. 7.

Thyroidectomy. Twenty days after operation.
In discussing the goitre operations of the five years between 1905 and 1910, in the Surgical Clinics of the Berlin Charity Hospital, Walz accords the preference to local anaesthesia. There was only one death among 120 benign goitre cases. In the experience of Enderlen, local anaesthesia failed in only a single instance, in the case of a child, among 166 goitre operations, during 1909. In the Clinics of Rehn, in Frankfort-on-the-Main, the preference is accorded to local anaesthesia in these cases. In reporting 510 and 452 goitre operations, respectively, from the Innsbruck Surgical Clinics, 1909–1910, Schloffer states that local anaesthesia with different agents proved very satisfactory. Fairlie Clarke, in England, had very favorable results with local anaesthesia in goitre operations, such as excision of one-half of the gland or ligature of both superior thyroid arteries.

As a pupil of Kocher I have been interested in local anaesthesia in goitre surgery, and added experience has steadily strengthened my convictions concerning the expediency of this method.

Manipulations on the goitre are said to be but slightly painful in themselves, the actually painful steps of the operation being limited to the incision of the skin, and the displacement, or so-called luxation, of the goitre. It is undoubtedly possible to operate painlessly, or very nearly so, in a large number of cases, by means of local anaesthesia. The skin incision is thus rendered absolutely painless, and in the further course of the operation, the patient is troubled not so much by pain, as by a sensation of tightness and pressure, during the delivery of the goitre. Serious and protracted goitre operations have been performed under Schleich's infiltration anaesthesia, without causing special pain to the patient.

The employment of local anaesthesia may place a greater strain upon the operator, whose work may be hindered by the defensive movements of the patient, on account of the pain due to traction upon the nerves or the application of ligatures to blood-vessels. It is here that combination of the related
methods of local anaesthesia and anoci association will exert a beneficial effect, by diminishing the nerve strain and shock of patients both during and before operation.

The same purpose is served by proper preliminary medication, and by the personal contact of surgeon with patient, confidence which results in a state of nerve-calm.

The possible disadvantages of local anaesthesia, in a small number of cases, consist in the added difficulty and length of the surgical procedure, the increased demands upon the operator's skill and self-possession, and the intractability or hysterical condition of certain patients. Other objections, such as an unfavorable influence of the local injection upon the repair process, are not tenable.

Goitre must be regarded as a surgical disease, and operative intervention naturally calls for the control of pain. The physician who has the comfort and safety of his patients at heart will give them the utmost benefit of what is, perhaps, the greatest blessing modern chemistry has bestowed, namely, the arbitrary arrest of pain in the field of operation, by means of local anaesthesia.

Any of the local analgesic agents may be employed—stovaine, cocaine, novocaine, etc. In the case illustrated here-with, novocaine was employed, 1 per cent. in skin, and 1/4 per cent. in the deeper structure. The case was one of exophthalmic goitre, with large vascular thyroid, and with marked heart and eye symptoms. Preliminary medication of 1/4 of mor-phine, and 1/150 of atropin, is given half an hour before operation.

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STOVAlNE SPINAL ANALGESIA IN PRISON SURGERY.*

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The use of stovaine as an anaesthetic agent at the Sing Sing Prison hospital dates back to 1908 when Dr. Fred E. Lettice, the then Prison Physician, encountered a situation which endures in the prison system of New York State, namely, the utilization of convict help to that extent that even in the various prison hospitals no civilians are employed. This system, while most creditable to the general prison administration, works rather against the surgical operator, as the absence of trained assistants is a serious handicap. Dr. Lettice not caring to assume the responsibility of the oversight of a convict administering ether was led to experiment with stovaine. An idea as to how well he succeeded may be gained from the fact that to-day no operation upon the body below the level of the umbilicus is performed under any other anaesthetic agent than stovaine. The results in the past five years have been particularly brilliant.

The practice of medicine in penal institutions is, naturally enough, similar to other institutional medical practice. Yet, in no variety of institutions is the degree of superstition of the inmates as marked. The old bugaboo of the "black bottle" still holds sway. The malingerers and the members of the new generation are the ones that continually present on sick call. Let a death occur in one of the wards and invariably a number of the patients in that ward speedily recover and request to be discharged. This in illustration of the fear of the hospital held by the great majority of the prisoners.

The foregoing facts are simply mentioned to call attention to the psychological side of prison medicine and also to bear

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out my statements regarding "stovaine." Given a certain sur-
gical case having undergone operation and a post-operative
death occurring, the convict body to a man would claim that
the stovaine was responsible, and, as a direct result, surgical
procedure would be looked upon with a most pronounced degree
of doubt by the convicts. As no post-anæsthetic death has
ever occurred, and as the results have been so uniformly suc-
cessful, we are often confronted with complaints to the Warden
that we are negligent, and, in fact, it is not an unusual thing to
have a convict urgently insist upon an operation.

To one versed in prison medicine the foregoing carries a
potential story. It tells that the fear of surgery has been
removed from the minds of probably the most skeptical, super-
stitious and doubting class on earth, namely, the convict body
of a large prison. The reason for the assumption of this
attitude is due, not to superlative surgical skill or wonderful
nursing, but in fact to stovaine analgesia. The fact that its
use was instituted simply as an expedient, due to the lack of
proper assistants, who would be able to administer ether, and
the fact that to-day its continued use has become a routine,
indicates undoubtedly its value.

By many surgeons the use of stovaine has been sharply criti-
cized,—it has been termed dangerous—it has been stated that
its field of usefulness is too limited, and many other objections
raised to its employment. I do not seek to deny that its use is
always unattended by danger, surely in a case in which other
agents are strongly contra-indicated the use of any anaesthetic
would be attended with a certain degree of risk and this is true
of stovaine when employed in depressed physical conditions.
When employed in a routine method, the fatality record will be
practically negative. It has been my experience that the sur-
geon who condemns stovaine will admit that in cases of cardiac
and renal disease where the use of ether is hopeless, spinal anal-
gesia may be considered, as there will probably be less danger
of a death occurring. This reasoning appears to me rather
illogical for surely if stovaine is a relatively safe, or rather less
dangerous agent than ether, in cases with grave organic lesions,
why should it not be more than relatively safe when used in the ordinary routine of surgical practice, and upon cases uncomplicated by some chronic affection. The surgeon, by assuming this attitude, has, therefore, sharply limited the field of usefulness himself, by only utilizing this agent in cases depressed by organic disease. That the field of usefulness is limited is true, yet, nevertheless, from a surgical stand-point, any agent that produces a satisfactory and complete analgesia, which permits surgical procedure below the level of the umbilicus, possesses a rather broad field of application. I have never experimented in producing a high analgesia, but rather have contented myself in trying to improve and safeguard the lower administration of stovaine.

The advantages of the use of this form of analgesia would seem to outweigh the disadvantages.

The disadvantages are:

a. Inability to change the dosage after once being administered. Yet, in cases where stovaine absorption has caused a marked depression this can be controlled by altering position of patient and the hypodermatic administration of strychnine.

b. In prolonged operations there is the possibility of the effects of the stovaine passing. I have been confronted with this situation but twice, and in both instances the wound was being closed, pain being complained of as suture needle passed through the skin. This condition was readily controlled by a hypodermic of morphine. Against the possibility of analgesic effects wearing off before completion of operation, I wish to call attention to a case of large rectal prolapse. Time consumed in excision was 95 minutes, analgesia was perfect for that time and lasted for 35 minutes more.

Against the disadvantages as enumerated, we have the following advantages:

a. Consciousness.—Whether the retention of consciousness is a distinct advantage is problematical. In some cases the patient's knowledge that he is not going to be "put to sleep," but will remain perfectly conscious although insensible to pain, fortifies him, and the attendant apprehension immediately be-
fore operation is not so marked. Then, too, during the operation a line may be obtained on the patient's condition by his expression of state of feeling.

b. Perfect analgesia. If spinal tap has been successfully performed, and a free flow of fluid results stovaine gives a perfect analgesia.

c. Absence of post-operative shock. Immediately upon completion of operation a quarter of morphine is given hypodermically. This practically controls post-operative shock, and delays return of painful sensibility, so that with its reappearance a goodly degree of toleration has been established.

d. Absence of post-operative pulmonary or bronchial irritation. In contradistinction to ether or chloroform there is no elimination of vapor from the pulmonary or bronchial membrane, hence, no factor to cause any inflammatory condition of these structures.

e. Recovery from anesthesia unattended by stomachic disturbances, as vomiting, retching, etc. Any nausea or vomiting is secondary to the "absorption reaction," is more or less reflex in character, and quite disappears before patient leaves the table.

f. Absence of marked motor restlessness as is present in ether anesthesia when patient is emerging from anesthesia. This is due to the fact that stovaine is properly an analgesic agent and consciousness has been retained.

g. Immediate resumption of gastro-intestinal activity. Subsequent to inhalation anesthesia there is a period of 48 to 72 hours before the stomach will functionate properly, due to the irritation occasioned by and the absorption of ingested ether vapor. The inability to assimilate nourishment occasions a physical depression and causes a nutritional loss that naturally prolongs period of convalescence. Following stovaine analgesia nutriment is commenced eight or ten hours subsequent to operation and diet rapidly increased. This insures a more rapid convalescence.

h. Absence of after effects. The only case developing a nervous lesion subsequent to operation was that of a prisoner
fifty-nine years of age, who suffered an attack of apoplexy with resultant hemiplegia four months subsequent to operation for hernia, in which stovaine analgesia had been employed. The prisoner's father and uncle had died of apoplexy, prisoner himself presented a well-marked arterial thickening, gave a history of alcohol, and was the father of nineteen children. The chance that stovaine was the cause of attack in this case would seem to be rather remote. In another case, a prisoner forty-four years of age with a left hemiplegia was operated upon for an inguinal hernia under stovaine with no untoward after-effects.

I will now describe briefly the procedure I follow:

The general preparation of patient for stovaine analgesia does not require much attention. Cases admitted to the hospital for operation on the following day receive soft diet and a dose of magnesium sulphate at bed time. In the morning if the bowels have not moved a soapsuds enema is given. A couple of hours before operation is to begin patient receives a glass of milk and one toasted cracker. It has been observed that if a small amount of food, as described, is given, there is less likelihood of nausea or vomiting after stovaine has been injected.

In a number of emergency cases stovaine has been administered immediately upon patient's reception to hospital without regard as to condition of the gastro-intestinal tract. In these cases it has been well borne, although it is quite usual for the bowels and bladder to involuntarily empty while patient is on the table, due to the stovaine relaxation of the sphincters.

In the special preparation for the injection the back is thoroughly scrubbed with tincture of green soap and lower half is shaved. By means of hot water and hot packs all soap is removed and back rinsed in absolute alcohol. A pad about 6 inches square and saturated with alcohol is placed over spinal region at site of injection and held in place by a bandage. This is permitted to remain fifteen or twenty minutes and is not removed until patient is on table in position to receive injection. In the single instance I used iodine the analgesia was not as
deep as usual and passed rapidly. I attributed it to the fact that needle carried a minute quantity of iodine with it and it affected the solution.

**Outfit and Technic.**—The syringe used is the Kny Scheerer Co.'s model of the Bier syringe for spinal anaesthesia. It consists of a glass barrel and metal plunger, and has a capacity of 2 c.c., the needles, two in number and 8 cm. long, are steel with bevelled points. The point of the obturator is bevelled to the same slight angle as the needle point, so that when it is in position within the needle, the needle point is solid. The needle presents a double shoulder, which is flattened on either side and which affords a firm grasp. The shoulder also presents a ground bevelled opening, which receives the tip of the syringe.

The syringe and both needles are wrapped in gauze and boiled in distilled water for fifteen minutes. Formerly a soda solution was used and an occasional defective analgesia occurred, notwithstanding the fact that syringe and needles had been most carefully rinsed and cleaned in hot sterile water.

The syringe is inserted into one of the needles and the contents of ampoule carefully drawn up. The needle is now discarded, syringe held tip up and excess of solution over desired dosage is permitted to escape. Syringe is carefully laid on a sterile towel on dressing table and the other needle used to make puncture.

Patient sits squarely on table with the legs hanging over the side. Head is bent downward on chest, arms to sides and fore-arms crossed over lower abdomen and resting on thighs. This arches the spine slightly forward and permits entrance of needle in desired interspace. The iliac line represents spine of the fourth vertebra. With this landmark the desired space is noted.

Usually I inject in the space between the second and third, third and fourth or fourth and fifth, choosing the interspace that presents the widest separation. After deciding on point of puncture, assistant sprays it with ethyl chloride and then with the left thumb, as a guide, on the vertebra above the interspace, the needle in the right hand is made to enter the skin at right angles about the middle of the interspace and a quarter of an
inch to either side of the midline. It is carried directly forward until it engages the yellow ligament which imparts a definite resistance to the feel. Needle is now advanced further forward, slowly and cautiously until it punctures the dura. As it penetrates the dura the sensation is about the same as would be given by piercing a drum head with a sharp pointed surgical needle. The obturator is now withdrawn and a free flow of cerebrospinal fluid presents. The obturator is replaced, operator rinses hands in sterile water and then again removes obturator. This time the left thumb is placed over the head of the needle. If an amount of fluid approximating two or three drachms has escaped, the syringe containing the dose of stovaine is placed within the reach of the right hand which carefully adjusts it securely to the needle. The plunger of the syringe is now slowly drawn back siphoning out enough fluid to fill syringe and make a solution of stovaine and cerebrospinal fluid. When syringe is filled to capacity plunger is slowly carried forward and the mixed solution instilled within the spinal canal. Upon occasion I have varied this procedure by removing the filled syringe and by slight agitation thoroughly mixing fluid and stovaine. This method seems to work especially well. While the appearance of the analgesia is somewhat more delayed there is undoubtedly less absorption reaction and analgesia when established is satisfactory. After solution has been injected the needle with syringe attached is gently removed. A small piece of adhesive plaster is placed over puncture wound. Patient is permitted to remain in an upright position for two or three minutes and then carefully lowered onto table and a firm pillow placed under head. This method is followed because the solution used is heavier than spinal fluid solution. If the operative measures are directed toward the perineum, rectum, external genitals or extremities there is no departure from this procedure. However, should operation necessitate opening the peritoneum the hips are elevated for a couple of minutes by means of blocks placed under the legs at the foot of the table. This is to permit the mechanical extension of the stovaine solution higher up the
canal. Usually analgesia to border of ribs appears within the two minutes. After the injection analgesia usually presents in from five minutes up to fifteen and lasts from three-quarters of an hour up to two hours. The solution employed is the Kroenig formula of “stovaine-billon.” It is a 4 per cent. solution of stovaine in 10 per cent. solution of sodium chloride and is sealed in ampoules of 2 c.c. The ampoules are easily rendered aseptic by rinsing in alcohol, they are easy to handle and the solution is apparently a stable one. The billon ampoules have been used exclusively on account of their convenience and also because it has seemed inadvisable to attempt the preparation and handling of a freshly made solution in the surroundings. We have never had any infection of the canal, cord, or adjacent structures following the use of stovaine. The dosage varies according to the case. Eight or ten minims suffice in the slight operations upon the external genitals. In appendectomy and herniotomy a heavier dose is employed. I have at times used 25 drops. The comparatively large dosage has been used as I never administer a primary dose of morphine.

In the cases that present a well-marked “absorption reaction” there is nausea and infrequently vomiting. Some epigastric pain is complained of but these symptoms rapidly pass. Usually a few teaspoonfuls of water or a few drops of aromatic spirits of ammonia well diluted controls the condition if it appears to persist. The one great danger is that of respiratory depression and paralysis. This condition is secondary to the extension and absorption of stovaine high up the spinal canal. In one case, 55 years of age, herniotomy, this was well marked. Head was elevated and strychnine administered hypodermatically. Condition passed off in about five minutes without the necessity of resorting to artificial respiration. In this case I feel that a definite idiosyncrasy was present.

The after-treatment of stovaine analgesia is practically negative. A hypodermic of morphine as has been previously stated is administered at completion of operation. This lessens the post-operative shock as pain sensibility is regained. In occasional cases, severe headache is encountered. This is best
treated by absolute rest, ice-bag and careful elevation of the
ead. If persistent, fluidextract ergot in drachm doses usually
gives relief.

The following table shows the variety of operations in
which stovaine has been successfully employed as an analgesic
agent at Sing Sing:

<table>
<thead>
<tr>
<th>Operation</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herniotomy, inguinal, single</td>
<td>58</td>
</tr>
<tr>
<td>Herniotomy, inguinal, double</td>
<td>2</td>
</tr>
<tr>
<td>Herniotomy, inguinal, strangulated</td>
<td>2</td>
</tr>
<tr>
<td>Herniotomy, inguinal, and hydrocele</td>
<td>1</td>
</tr>
<tr>
<td>Herniotomy, inguinal, and appendectomy</td>
<td>1</td>
</tr>
<tr>
<td>Herniotomy,inguinal and undescended testicle</td>
<td>1</td>
</tr>
<tr>
<td>Herniotomy, femoral</td>
<td>1</td>
</tr>
<tr>
<td>Hemorrhoids, internal and combined</td>
<td>15</td>
</tr>
<tr>
<td>Fistula in ano</td>
<td>16</td>
</tr>
<tr>
<td>Appendectomy</td>
<td>14</td>
</tr>
<tr>
<td>Circumcision</td>
<td>14</td>
</tr>
<tr>
<td>Varicocele, radical</td>
<td>13</td>
</tr>
<tr>
<td>Hydrocele, radical</td>
<td>9</td>
</tr>
<tr>
<td>Hydrocele and varicocele, radical</td>
<td>1</td>
</tr>
<tr>
<td>Varicose veins, leg</td>
<td>2</td>
</tr>
<tr>
<td>Prostatectomy</td>
<td>2</td>
</tr>
<tr>
<td>Urethral fistula</td>
<td>1</td>
</tr>
<tr>
<td>Urethrotomy, external</td>
<td>1</td>
</tr>
<tr>
<td>Orchidectomy, tubercular</td>
<td>2</td>
</tr>
<tr>
<td>Orchidectomy, sarcoma</td>
<td>1</td>
</tr>
<tr>
<td>Peritonitis, tubercular</td>
<td>1</td>
</tr>
<tr>
<td>Rectal prolapse, excision</td>
<td>1</td>
</tr>
<tr>
<td>Inguinal adenitis, excision</td>
<td>2</td>
</tr>
<tr>
<td>Redundant prepuce, excision</td>
<td>1</td>
</tr>
<tr>
<td>Exploratory incision</td>
<td>1</td>
</tr>
<tr>
<td>Compound fracture, both ankles, reduction</td>
<td>1</td>
</tr>
<tr>
<td>Exostosis, tibia, excision</td>
<td>1</td>
</tr>
<tr>
<td>Necrosis, tibia, curettage</td>
<td>1</td>
</tr>
<tr>
<td>Hallux valgus, excision</td>
<td>1</td>
</tr>
<tr>
<td>Toe, amputation</td>
<td>2</td>
</tr>
</tbody>
</table>

Total                                          | 169   |

The average age of the prisoners operated upon was from
25 to 30 years. From the foregoing table it will be seen that
prison surgery embraces a broad field and the use of an anal-
gesic agent such as stovaine will aid the prison physician decid-
edly in overcoming the difficulties that beset him in the treat-
ment of surgical cases.
MEDICOLEGAL ASPECTS OF ANÆSTHESIA.*

BY F. HOEFFER McMECHAN, M.D.,
OF CINCINNATI, O.

While the anæsthetist is bound by those rules which govern the professional conduct of all registered or licensed practitioners, still, in many respects, his position is ill defined and subject to modifying circumstances. This is due to the fact that only during the last few decades has the anæsthetist been acquiring some independence, and consequently only a limited number of legal decisions are available for his guidance. These medicolegal aspects of anæsthesia, however, are of sufficient importance to demand conscientious consideration from those who are making anæsthesia a "specialty."

In the ordinary routine of his work the first legal obstacle that confronts the anæsthetist is the question of consent.

Consent.—No person can be legally anæsthetized without consent, unless the anæsthetist opens himself to a charge of assault. In the case of children and the insane, consent must be secured from parents, guardians or those legally authorized to give it.

Commenting on this subject,¹ it is held in England that the power of a parent to withhold consent, even to a necessary operation, is absolute. On the contrary, Judge Leuders, of the Hamilton County Probate Court, Cincinnati, O., recently removed a child from the guardianship of an aunt, who was having her treated by a "faith curist," to the custody of a grandmother, who promised to place the child under proper medical treatment for the contagious disease from which it was suffering. It is probable that a similar jurisdiction would be exercised by the Juvenile Courts, should their medical officers or outside physicians appeal from parental non-consent to anæsthesia or operative procedures, especially in cases of urgency, when the life of the child was involved.

* Read before the American Association of Anæsthetists, June 18, 1913.
¹ Lancet, May 6, 1911, p. 218.
It is also obvious that many young people, particularly among the working-classes, although legally "not of age," are practically independent of their parents. The Canadian Courts furnish a case turning on this point. The patient having agreed to an operation, to which his parents had not consented, the judge's decision was against their protest, on the intrinsic merits of the individual case, rather than upon any fixed principle or newer interpretation of the law.

Actions have been brought for alleged anaesthetization without consent, especially when the patient and anaesthetist have been alone together, and the anaesthetist has also assumed the rôle of operator. The majority of these cases have failed on the grounds that anaesthetization by force was impossible and that there was collateral evidence of consent; but in each instance anaesthetists have been put to the inconvenience of framing a legal defence.

As early as 1867, in Absolom v. Statham, Judge Cockburn of England, summing up an action brought against a medical man for forcibly administering chloroform to the plaintiff against her will, for a dental operation, issued this dictum from the bench, that: No surgeon had the right to anaesthetize an individual or perform any operation against the will of a patient, so long as the person preserved consciousness and will, without opening himself to a charge of assault.

Thus, if a patient, who is about to be operated upon, changes his mind during the induction of narcosis, and objects, the anaesthetist must desist from any further efforts at anaesthetization, unless the anaesthetic has so far taken effect that he may reasonably infer that the conscious exercise of judgment has been lost. This seems rather a far-fetched contingency, but a personal experience proves the contrary.

Illustrative Case.—Some years ago Dr. Hinckley, surgeon to St. Mary's Hospital, Cincinnati, O., was to operate upon a woman for appendicitis. The patient was apparently resigned to the

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*J. D. Mortimer: Anaesthesia and Analgesia, University of London Press, p. 256.
ordeal, until during the induction of anesthesia with chloroform by the drop-method, when she used a woman's prerogative and abruptly changed her mind. She sat up on the operating-table, and demanded to be returned to her room, unoperated. Persuasion was found to be useless and she was accommodated in her desires, all the medical men interested, washing their hands of the case. It is the unexpected that occasionally happens. To have attempted forcible induction of anesthesia under the circumstances could easily have led to the preferment of a charge of assault, and in case of an anesthetic fatality, there would have been additional grounds for a prosecution of manslaughter.

The anæsthetist may also be placed in a rather embarrassing position should the operating surgeon find it impossible to keep within the limitations of the operation to which consent had been given; and not only modify the intended operation, but perhaps attempt to substitute an entirely different one, of which the patient or relatives may afterward disapprove, or which of itself may inject the important element of fatality into the procedure. Under certain operative circumstances the anæsthetist would find it impossible to withdraw without jeopardizing the patient's life, and he can only protect himself by entering a protest against the procedure, while at the same time he bends his every effort toward a fortuitous outcome. The case of Lawson v. Crane & Hall has an indirect bearing on this point.\(^8\)

The lower courts of Vermont had awarded a judgment for damages in favor of the plaintiff. During the trial, however, testimony of the defendant, that he had protested against the contemplated operative procedure, although he had later administered the anæsthetic during its performance, was excluded. On appeal the Supreme Court held that: as the defendant had already advised against any operation at the time and place it was performed, but his advice had been disregarded, and the operation had been performed contrary thereto, and was not subject to his control, he having only administered the anæsthetic in the capa-

\(^8\) Supreme Court, 74 Atl. R. 641, Jour. A.M.A.
city of an assistant, therefore he was not called upon to again object to or protest against the said operative procedure, and hence no inference of approval could be drawn against the defendant from his silence in that respect. Therefore judgment for the plaintiff is reversed and his petition dismissed with costs.

The recent passage of Workmen's Compensation Acts by the legislatures of Ohio and California, although the New York Act has been declared unconstitutional, adds a new element of consent to anæsthetization and operation for medicolegal consideration.

In the adjudication of the Workmen's Compensation Act, passed by Parliament in 1906, the English courts have held that an injured employee must submit to any reasonable operative procedure that will lessen his disability. The case of Bourne v. The Middle-Sussex Water Board notes an exception to compulsory submission to an operation, if there is danger from the anæsthetic. The following is a brief summary of this important case.

Henry Bourne, laborer, sixty-two, claimed compensation under the Workmen's Compensation Act, before the Haywards Heath County Court, March 18, 1909, for injuries sustained while in the engine room at the Balcombe Water Works, on September 28, 1908, under employment of the Middle-Sussex Water Board. Bourne was called upon to assist in moving a heavy valve, which fell on one of his hands, causing serious injury. He became totally disabled. The employer, on advice of a medical practitioner, suggested that the hand should be operated upon with a view of straightening the fingers; contending that if this was done Bourne would be able to resume his work in the ordinary way.

The plaintiff, however, refused consent to any operation and two medical men gave evidence that an operation was inadvisable as the plaintiff was not a proper subject for an anæsthetic. The respondents contended that this objection was not a reasonable one and asked for the decision of the judge: whether the plaintiff's present condition was not the result of his unreasonable objection

to undergo an operation. His honor, Judge Scully, held that:
the plaintiff's objection to an operation on account of the coinci-
dent danger of the anesthetic was not unreasonable and made an
award of compensatory weekly indemnity.

Similar cases are bound to arise in the adjudication of
Workmen's Compensation Laws in this country, and as several
fatalities under anesthesia have already occurred in England,
to persons submitting to operation under the requirements of the
law, any individual case in which there is grave danger from
the anesthetic should be carefully considered, before consent
to an operative procedure is legally demanded.

The question of consent to an examination under an anes-
thetic in connection with a military pension, was brought be-
fore Parliament, in 1907, by Mr. Wedgwood Bain. It appears
that a soldier named Craig had been required by the War Office
to undergo an examination under an anesthetic before the
continuation of his pension would be granted. Mr. Haldane,
answering for the War Office, stated that an anesthetic would
not be administered unless it was considered safe by the medical
authorities, and the latter would be glad to receive any evidence
that Craig was unfit to submit to general anesthesia; but the
ultimate decision as to whether he was or was not fit must
rest with the medical examiners of the War Office. In the
event of death under the anesthetic the man's dependents would
have no claim to compensation against the government. 5

Mr. Haldane's last remarks have since been abrogated by
several decisions under the Workmen's Compensation Law,
which will be quoted at length later on.

It must also be remembered that in the employment of
untried anaesthetic agents or in initiating newer methods of
administration, a grave responsibility rests with the anaesthetist,
unless the patient is fully advised of the experimental character
and possible untoward results of the procedure, and his consent
to the trial has been previously obtained.
Two very important questions now arise: Who is legally qualified to administer anaesthetics, and what legal regulations regarding the administration of anaesthetics have been promulgated.

The limiting of the administration of anaesthetics to legally qualified practitioners has been presumed in the context of the various state medical practice and license laws, without having been definitely expressed. The nurse-anaesthetist abuse, perpetuated and endorsed by certain surgical clinics, has insidiously crept into the ranks of the profession. There is every promise that this abuse will be speedily abolished by amendments to the medical practice acts or by action of the state societies.

Undoubtedly the opinion of Attorney-General Hogan of Ohio will prevail. He holds that: the use of anaesthetics is a "medical act," and consequently the administration of anaesthetics must be limited to legally qualified practitioners of medicine or dentistry.

There is no Nurse's Bill extant which expressly conveys the legal qualification to administer anaesthetics, and the new Nurse's Bill, now before the Ohio legislature, specifically prohibits the practice. Undoubtedly the agitation of the subject in New York will eventuate in a similar prohibition.

In August, 1909, the Chief of the Board of Health, Vienna, issued to all hospitals and out-patient departments of the Austro-Hungarian Empire, the following regulations regarding the administration of anaesthetics:

1. To have each and every patient especially examined before being put under the influence of any anaesthetic.

2. To limit the use of inhalation anaesthesia to such cases in which this method of narcosis was absolutely necessary. In all other instances local or regional analgesia was to be considered the method of choice.

3. Under no conditions would the same physician be allowed to anaesthetize and operate upon a patient.

4. Legally only qualified medical men would be privileged to administer anaesthetics.
5. Students would be permitted to administer anaesthetics only after instruction and then only under proper supervision.

6. Finally the chemical purity and non-deterioration of the anaesthetic agents would have to be determined before use.®

Certainly a set of regulations worthy of the highest commendation and the most widespread promulgation on the part of the Health Departments of our various states and larger cities, particularly in those medical institutions within their immediate control.

At its Dublin meeting, November 10, 1910, the Royal Academy of Medicine discussed proposed legislation regarding the administration of anaesthetics, and the resolutions passed are embodied in a Bill, which the Society of Anæsthetists, London, under the leadership of Sir Frederic Hewitt, is attempting to pass through parliament.

The general provisions of this bill are as follows:

1. That it is advisable in the public interest that the administration of general anaesthetics to render persons unconscious during any medical, surgical, obstetrical or dental operation or procedure, should be restricted by law to registered medical practitioners, with this exception, that the specification of the anaesthetic drugs which may be employed by registered dental practitioners during dental operations or procedures, should be made in a schedule, power being reserved to the Privy Council on the recommendation of the British Pharmacopoeia to add to or vary the specified list from time to time as occasion may require.

2. That provision should be made for the instruction of medical and dental students in the administration of anaesthetics.

3. That the administration of local analgesics for producing insensibility to pain during any surgical or dental operation or procedure, by the introduction beneath the skin or mucous membrane of any fluid or other substance by a hypodermic needle or in any other way, should be restricted by law to

*British Medical Jour., August 21, 1909, p. 496.
registered medical practitioners, registered dentists, or to persons acting under their immediate supervision, such as students and internes.  

So much for the regulation of the administration of anaesthetics under the civil law. The state of New York has gone further, and has incorporated a section in its penal code. This section reads as follows:

Section 1752: A person, other than a duly licensed physician or surgeon engaged in the lawful practice of his profession, who has in his possession any narcotic or anaesthetic substance, compound or preparation, capable of producing stupor or unconsciousness, with intent to administer the same or cause the same to be administered to another, without the latter's consent, unless by direction of a duly licensed physician, is guilty of a felony, punishable by imprisonment in the state prison for not more than ten years.

The occurrences of fatalities or untoward results under anaesthesia bring the anesthetist before the bar of Coronial inquiry, and leave him open to suits for malpractice or prosecutions for manslaughter. Scotland is perhaps the only country in which no coroner's inquests are held upon "deaths under anaesthesia."

With regard to deaths under anaesthetics the Medicolegal Committee of the British Medical Association, at the annual session in 1910, reported as follows in connection with the law of coroners:

Most coroners hold, it appears, that when a person dies under an anaesthetic given for the purpose of a surgical operation, the death is an unnatural death, within the meaning of Sec. 1 of the Coroner's Act of 1887, and that the coroner is bound to hold an inquest.

Others, however, consider that they have discretion, if after preliminary inquiry they are satisfied that the administration of the anaesthetic was necessary, that it was properly given by a competent person, and that death was due to inevitable accident.  

In the public interest we think that the coroner ought to have this discretion. Every case of death under anaesthesia, whether it occurs in a

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2 British Medical Jour., vol i, 1910, p. 826.
public institution or a private house, should be reported to the coroner. If the coroner on due inquiry is satisfied that all due care and skill have been used, we think it is undesirable that there should be an inquest.

R. Henslowe Wellington, an English coroner of broad experience, in writing upon coroner's law, deplores the undesirable tendency to cause alarm in the minds of the public by sensational reports of inquests on deaths under anaesthesia.®

On the contrary, Dr. Waldo, Coroner for the City of London and Southwark, advocates inquests in all anaesthetic fatalities. Also he holds that the legal responsibility for the casualty rests with the person by whom the operation is controlled, that is, by the surgeon. He maintains that if the operator can be justly accused of selecting an assistant, who had not had sufficient experience to enable him to give the anaesthetic properly, and was himself so engaged in the operation as to be unable to personally supervise the administration, then in case of accident the surgeon can be held liable under the law, and in case of a charge of malpractice or a verdict of culpable neglect by a jury, it might become the duty of a coroner to commit the operator, not the anesthetist, for manslaughter; except in cases where the anesthetist happened to be in an unfit condition at the time or showed gross carelessness.®

Commenting on this matter the Law Journal says:

Where patients submit to or are subjected to operations which require or are better done under anaesthetics, they and those whose subscriptions maintain the hospital are entitled to some guarantee that the utmost skill and care shall be used, and it is well that an inquiry has been instituted with reference to the very frequent deaths in hospitals under anaesthetics, for it is not desirable to have these matters decided by a prosecution of doctors for malpractice or manslaughter.

In a discussion at the meeting of the Medicolegal Society, London, April 27, 1909, regarding the relative responsibility of surgeon and anesthetist, Mr. Cowburn stated that he could find no recorded case in English law in which either criminal or successful civil action had been brought against a medical

* Lancet, October 8, 1910.
* British Medical Jour., January 4, 1908.
man on account of death resulting from or occurring whilst under the influence of a general anaesthetic. Each case had been tried on the facts and the jury's verdict had been given in the light of the attending circumstances.

Mr. Cowburn further submitted that if negligence could be proven in respect of the administration, the medical practitioner actually administering the anaesthetic, was liable, not the surgeon, who was engaged in the operation. If the surgeon, however, took upon himself to decide the particular kind of anaesthetic to be employed, or the technic and apparatus to be used, or the amount of the anaesthetic to be administered, he would be held jointly responsible with the anaesthetist for any unfortunate result to the patient.11

But when a nurse or a student was engaged in the administration of an anaesthetic under the direct supervision of a medical man, there then existed the relationship of master and servant, and in the event of any untoward accident the qualified practitioner could be held responsible.

In those cases arising from deaths under anaesthesia, which have come to trial in the English courts on pleas for damages or on prosecutions for manslaughter, the following defence has always proven successful: (1) that the administrator was a qualified medical man, that (2) both the operation and anaesthetic were necessary, that (3) the administration was conducted with the experience and knowledge ordinarily demanded, and that (4) death was unavoidable and not due to carelessness or want of skill.

It would appear for the future that the apportionment of responsibility between the surgeon and anaesthetist, in the event of a casualty, would more or less depend upon whether the anaesthetist was acting merely as an assistant or had been employed as a "specialist". It is gradually becoming the custom for coroners to summon the anaesthetist in cases of inquests for deaths under anaesthesia, and not to summon the surgeon, unless death has been due to some operative accident?

rather than to the anæsthetic. In these days of specialism anæsthetization can no longer be considered merely a part of the surgical procedure.

Mortimer suggests that in becoming a “specialist,” the anæsthetist opens himself to actions for damages on account of injuries sustained during anæsthetization; for example, the breaking off of a tooth from forcibly opening the mouth; injuries sustained during struggling; bruising of the tongue; accidents or failures such as loss of an eye from a movement of the head or inability of the surgeon to complete an operation, or such after-effects as brachial paralysis, burns from hot water bottles, etc. While there is considerable speculation in the foregoing, still the anæsthetist through carelessness may readily bring a damage suit down upon the head of the operating surgeon or the trustees of his hospital.

There is a case quoted in the American Encl. Digest in which, in a Western hospital, after a patient had been successfully operated, he was carelessly dumped down an elevator shaft while being returned to bed. In this case, the patient still being under the influence of the anæsthetic, the operating surgeon was mulcted of heavy damages.

There is a suit pending in the Hamilton Co. Courts, Cincinnati, against the German Deaconess Hospital, for burns sustained by hot-water bottles, while the patient was still under the influence of the anæsthetic, post-operatively. This suit revives interest in that of Ward v. St. Vincent’s Hospital, in which the Supreme Court of New York, by the opinion of Judge Gildersleeve, reversing the lower courts, on retrial, gave a verdict of $10,000 damages to the plaintiff for breach of contract due to injuries resulting from burns by a hot-water bottle, while under the influence of ether after an operation. In the lower courts the judge had directed a verdict for the defendant on the ground that the hospital was a charitable institution and therefore not liable for the negligence of employees. On appeal it was proven that the plaintiff was a pay patient, and hence the verdict for damages on the grounds of alleged breach of contract.

In the case of Hillyer v. Governors of St. Bartholomew’s Hospital, for alleged burns and brachial paralysis sustained during an examination under an anæsthetic, Justice Graham took the case from the jury on the grounds that the plaintiff had not proven negligence, and gave a verdict in favor of the defendants. On appeal, Lord Justice Farwell, said with regard to the question of liability that: surgeons and anæsthetists are not under the direction of hospital governors or bound to obey their orders, and therefore cannot be regarded as being their servants, for whose acts they would be liable. The governors were only subject to use care and skill
in selecting proper persons as members of the hospital staff. With regard
to nurses, although primarily the servants of the governors, they took their
orders from and were under control of the surgeons during an operation,
and thus in respect of duties so performed, ceased to be the servants of
the governors.

In the Edinburg Sheriff Court, in 1909, damages were awarded to a
plaintiff, who claimed them, in respect of injuries sustained by her through
being burned by a hot-water bottle, when under an anæsthetic for an opera-
tion. The claim was made against the Edinburg Hospital and Dispensary
for Women and Children, and the Sheriff Substitute, who found for the
plaintiff, adopted a contrary view of the law from that enunciated by the
Court of Appeal in the case of Hillyer v. The Governors of St. Bartholo-
mew's Hospital. The judgments of the Court of Appeal of England are
not binding on the inferior courts of Scotland and vice versa, although
they are often cited and generally receive the consideration due them.

From the foregoing it is apparent that the conscientious
anæsthetist is in duty bound to exercise every possible pre-
cautionary measure to prevent anæsthetic or postanæsthetic
accidents, unless he wishes to involve the operating surgeon or
his hospital in an action for malpractice or damages.

There are several decisions under the English Workmen's
Compensation Act, with regard to anaesthesia, which are of
importance. The case of Bourne v. The Middle-Sussex Water
Board has already been quoted, and under its ruling, working-
men not fit subjects for anaesthesia cannot be forced to undergo
operations for the mitigation of their disability. In Shirt v.
Calico Printers' Association Lim't'd, the Master of the Rolls,
on appeal, allowed the claim of a widow for compensation under
the Workmen's Compensation Act, on account of the death of
her husband under chloroform, while submitting to a second
operation of skin-grafting, to minimize his disability conse-
quent upon an accident. This ruling has been followed in several
cases, but in Charles v. Walker Lim't'd, the widow's claim
in respect to the death of her husband, under renewal of anaes-
thesia for a purpose other than the surgical intervention neces-
sitated by his accidental injury, was disallowed.

The facts in this case were as follows: The widow of the deceased
workman claimed compensation in respect of his death, which took place
while he was recovering from an anaesthetic administered to him for the
amputation of a finger, injured by an accident; the anaesthesia being re-
newed in order that a tooth, from which he had complained, might be removed. The county-court held that: It was at least as probable that death had been due to spasm caused by an attempt to swallow blood oozing into the mouth, as that it was due to the anesthetic administered for the first operation, and decided that consequently the widow had not made out her case. The Court of Appeal held that: the county court had rightly directed himself, and that the claimant had failed to discharge the onus which lay upon her to prove the facts upon which her claim depended.

This case emphasizes the absolute necessity of limiting anaesthesia to the operative procedure demanded under the Workmen's Compensation Law, in order that dependents may recover compensation in the event of an anaesthetic fatality.

In order to fully understand the not infrequent prosecution of hallucinatory and delusional false charges of rape under the influence of anaesthetic drugs, it becomes necessary to emphasize the fact that erotic sensations, such as women experience during sexual intercourse, occur during the induction period of narcosis. In two instances the author has observed this phenomenon, personally; and once, during the induction of anaesthesia, the actions of a young woman were of such a character as to embarrass all those who were present in the operating-room, although there was fortunately no realization post-operatively of the sexual excitation.

The mystery which has been allowed to surround the subject of sexuality is responsible for the unscientific delicacy with which the inquiry into the subjective sensual sensations of women has been pursued. But if these erotic hallucinations or fixed delusions take the practical form of a charge of rape, preliminary confinement to jail and a trial by jury, they pass from the domain of sentiment and enter the realm of legal medicine for investigation and adjudication.

Comparatively few members of the medical or legal profession sufficiently realize that women, during the induction period of narcosis, are subject to hallucinatory and delusional sensations, identical with the eroticism and orgasm associated with the sexual act. These erotic sensations arise quite subjectively, and without any extrinsic stimulus, aside from the
coincidental administration of the anaesthetic. The delusion of St. Catharine that the devil visited her and violated her person, when she was asleep and could offer no resistance, is no unique experience. Everyone familiar with asylum supervision knows that a certain percentage of women patients have this delusion, among others, that the medical superintendent comes nightly to their bed and enjoys their person during sleep. There is absolutely no foundation in fact for such delusions except the subjective, erotic sensations of these women.

How strongly such erotic delusions may become fixed in women's minds is evidenced by unfounded charges of rape by women, who have persisted in their belief, when relations or others were present during narcosis, under circumstances that rendered criminal assault physically impossible. Such being the case, it is advisable always to have another person, preferably a woman friend or attendant, present without intermission during the whole time that a female patient is under the influence of an anaesthetic, and that such other precautions be taken as will preclude the possibility of an unfounded charge being raised.

While designing women have occasionally brought false charges of rape for purposes of blackmail; or when already pregnant, in an effort to fix the parentage of the prospective infant upon some innocent medical man, still in most instances when hallucinatory or delusional false charges of rape have been pressed, modest, virtuous and refined gentlewomen have been the accusers.

Dudley Buxton in commenting on this subject says that: Chloroform, ether, nitrous oxide and even cocaine possess the property of exciting sexual emotions and in many cases produce erotic hallucinations. In certain persons sexual orgasm occurs during the induction of anaesthesia. Women, especially when suffering from ovarian or uterine irritation, are prone to such hallucination, especially during the menstrual period.

Turnbull in his Artificial Anaesthesia, quotes the case of Child v. Dash, which was tried at the Northampton Assizes, Nov. 9, 1877, by Mr. Justice Hawkins. After lying in jail from the 14th of September to the date of
trial, this surgeon's assistant was finally acquitted on a delusional charge of rape under anaesthesia, the accused being entirely cleared of any imputation in respect to the charge preferred against him.

Within a year of Morton's discovery of the anaesthetic effects of ether, the *Gazette Medicale* (Paris), July 31, 1847, reports the first recorded case of criminal assault under anaesthesia.

A patient went to a dentist to have a tooth extracted, and to avoid pain, he recommended her to inhale ether. The young woman was observed to leave the dentist's house in a very disordered state about three hours after entering it. This attracted the attention of her employer, who could not account for her long absence. The injured party, notwithstanding the effects of the ether, retained some recollection of what had transpired, and from some intimations she let fall suspicion was immediately aroused. She was examined by a physician who reported that her person had been violated. The dentist was arrested and prosecuted.

Taylor in his Medical Jurisprudence, quotes the law regarding criminal assault and narcosis as follows:

When narcotics or intoxicating liquids have been administered to a woman either by the prisoner or through his collusion, it matters not, in cases of rape, whether the narcotics have been given merely for the purpose of exciting the female, or with the deliberate intention of having intercourse with her while she was intoxicated or unconscious,—the prisoner is equally guilty.

In the case of Reg. v. Snarey, Winchester Lent Assizes, 1859, for criminal assault under the influence of an anaesthetic, there was a clear attempt at fraud. The prosecutrix asserted that she was instantly rendered insensible by the prisoner forcibly applying a handkerchief, saturated with an anaesthetic, to her face, and she accused him of having committed rape upon her. The charge was disproved by a distinct alibi, as well as by the improbability of all the circumstances. In a parallel case, that of White v. Howarth, the prosecutrix made a similar assertion, and added that she was aware of what was going on, but was unable to resist.

In attempts at criminal violence under an anaesthetic administered without the victim's consent, fear, excitement and struggling would all be against the possibility of arriving at a loss of voluntary power without deep narcosis. It is very doubtful whether a person, be he an expert or not, could anaesthetize a waking adult against his will, unless there existed a very unusual disproportion between the strength of the two individuals.

Also there is something suspicious about the attempted use of anaesthetics in burglary. Persons left to guard banks and
other places containing valuables have on numerous occasions affirmed that they were rendered unconscious while robbery was committed, but in almost all these instances, the persons uttering the charges have been either the actual depredators or in collusion with them. This subject opens up the question as to whether people can be anaesthetized during sleep. There is not time at our disposal to discuss this problem, but the reminder of Taylor is apropos. "Non omnes dormiunt quae clausos habent oculos." Not all are asleep because they have their eyes shut.

Occasionally in the routine of hospital service it becomes necessary to anaesthetize patients who are the victims of attempts at murder or manslaughter. Needless to say some of these patients are almost in extremis. However, if the anaesthetist uses skill and care he has nothing to fear, judicially, in case of a fatality. The Amer. & Eng. Encyl. of Law, quotes the following law on this subject:

Although a wounded man may die of strangulation produced by an attempt to administer restoratives to him, or from a surgical operation honestly believed to be necessary or from chloroform administered to facilitate such operation, or from an accident occurring during its performance,—yet as death from any such causes is directly referable to the original injury, this is to be regarded as the judicial cause of death.

In such cases, however, the anaesthetist for his own protection should keep a careful record of his procedure in administering the anaesthetic, as he may be called upon to testify in court.

In 1907, the Council of the British Medical Association, gave notice that any registered medical practitioner, who by his presence, countenance, advice, assistance or co-operation, knowingly enables as unregistered person to attend or treat any patient, is liable to be judged guilty of infamous conduct in a professional respect, and to have his name erased from the Medical Register. Since that time a practitioner has been stricken off the Register for administering nitrous oxide to enable a bone-setter to make an examination.
A personal experience in which the author is morally certain that a gynecologist of standing, performed a criminal abortion under the guise of a curettage for endometritis, emphasizes the fact that an anesthetist may unconsciously be misled into administering an anesthetic for an illegal operation. In the event of the anesthetist becoming familiar with the illegal nature of the proposed operation previous to the induction of narcosis, he would certainly be incriminating himself by continuing in the case. Likewise, should there be a suspicion of fraud with regard to the proposed operation, or any indication that it was being performed to obtain money under false pretences, the anesthetist would do well to retire from the case.

In the Brompton County Court, March 11, 1907, a point of some interest was raised in respect of fees due for the administration of an anesthetic. The plaintiff, an anesthetist, claimed 10 guineas from the surgeon defendant, for 10 administrations of an anesthetic to the latter's patients, contending that it was the custom for the medical man in charge of a case to hold himself responsible for any fees due to an anesthetist. This was necessary because knowledge of the patient in so far as the anesthetist was concerned and the relationship between them began and ended with the performance of the operation. Evidence for and against this view having been given by various persons the judge ruled that:

"The custom existed and gave judgment for the plaintiff for 6 pounds; this being an average between the fees variously stated as commonly paid anesthetists."

The further question of a contract assistant's right to anesthetic fees for services rendered another practitioner has been recently raised in England and has been disposed of as follows:

"Under the usual contract between a medical principal and his indoor assistant, the latter is required to give the whole of his time to the principal, and any professional remuneration he is paid belongs, legally, to the principal. The assistant's contract does not oblige him to work for another practitioner,
but if he does, he may not receive for himself a fee without the consent of his principal, and it is his duty to proffer him the fee."

In passing it is only possible to mention the value of anaesthesia, medicolegally speaking, in unmasking those who are malingering. M. Baudens, surgeon in the French Army, was the first medical authority to utilize ether anaesthesia as a means of exposing malingering. As early as 1847 he published two personal and illustrative cases of the practical application of ether to medical jurisprudence to distinguish feigned from real disease. Since that time the method has become a routine medicolegal procedure.

Before closing I wish to revive interest in a carbon tetrachloride death, which occurred in the shampoo parlors of the Harrodd's Department store of London, and which resulted in a trial for manslaughter. This sensational case was discussed in detail in the medical journals of 1909, and the Jour. of the A.M.A. in its Paris Letter, May 31 of this year, announces that Dr. Levassort has brought the subject of dry shampoo to the attention of the prefect of police and the Council of Public Hygiene and Health of the Department of the Seine, because of the danger of death from the fumes of carbon tetrachloride. On account of the prevalent use of certain dry-cleaners in the United States, the trade names of which betray the presence of this poisonous volatile anaesthetic, it would seem that this association might take some action in the matter of investigating the problem and issuing a warning against their use.

In closing, the remarks of Mortimer on the anaesthetist's conduct in court are especially apropos; he says that:

"In giving evidence that the anaesthetist should follow the general advice given to medical witnesses in books on Forensic Medicine. He should study the subject of inquiry carefully beforehand, considering what questions are likely to be put to him, how his evidence may be regarded by any one outside the medical profession, and any weak points which may be seized upon to his disadvantage. If coming before the
coroner, or a magistrate, or a county court judge, he should remember that the case may be carried further, and copies of his evidence given in the first instance, produced in the second, and that there should be no discrepancies from carelessness or lapse of memory between the evidence given on the two occasions.

"He should give his answers deliberately and distinctly, pausing at the end of sentences so that his testimony may be taken down. Any approach to levity, irritation or discourtesy should be avoided under all circumstances. Answers should be given in language, free as far as possible from technical terms and also from vague and exaggerated expressions. Answers should be limited to the questions asked, and the anesthetist should confine himself to facts, unless required as an expert to comment on them. He should object to involved, suggestive or hypothetical questions, and should appeal to the judge for permission to explain when a categorical answer would be misleading. Arguments and theoretical discussions are also to be avoided. No decided opinion should be expressed on insufficient data, and therefore one as to the cause of death should not be given in the absence of an autopsy, preferably conducted with the assistance of a skilled pathologist."
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May be used for Nitrous Oxide and Oxygen for prolonged anesthesia or for ether alone or in sequence.

Less disagreeable to the patient. Greatly lessens the dangers of anesthesia and difficulties of administration.

Gives an absolutely measured dosage. Re-breathing is under accurate control. Also quick induction, warmed inhalations and only ¼ to ½ the usual amount of ether used. Less secretion of mucous and less after-effects. Oxygen always ready. Is made of aluminum and easily portable. Is very simple and easy to use.

Send for full description.


Kansas City Missouri

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FROM COAST TO COAST
FOR THE
PAST 30 YEARS
The Profession and Hospitals have employed our

NITROUS OXIDE
AND
OXYGEN

If you are not using our products communicate with us for prices and particulars

STANDARD OXYGEN CO.
216-218 E. 42nd St.
NEW YORK

The Peculiar Advantage
of the
Marvel "Whirling Spray" Syringe
is that The Marvel, by its centrifugal action dilates and flushes the vaginal passage with a volume of whirling fluid, which smooths out the folds and permits the injection to come in contact with its entire surface.

Prominent physicians and gynecologists everywhere recommend the MARVEL Syringe in cases of Leucorrhea, Vaginitis, and other Vaginal Diseases. It always gives satisfaction.

The Marvel Company was awarded the Gold Medal, Diploma and Certificate of Approbation by the Societe D'Hygiene de France, at Paris, Oct. 9, 1902.

All Druggists and Dealers in Surgical Instruments sell it. For literature, address

MARVEL COMPANY, 44 E. 23rd St., New York

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HYPODERMIC TABLETS
that may be depended upon in every emergency

WHEN a physician administers a preparation hypodermatically he wants prompt, precise action. Dependence in such an emergency is upon a single little tablet. And that tablet—will it justify the faith? Is it medicinally active? Is it full strength? Is it soluble? These become living questions.

The practitioner who uses Parke, Davis & Co.'s hypodermatic tablets may do so with full assurance of their reliability.

Our hypodermatic tablets are of guaranteed potency. Every drug entering into their composition is rigidly tested, and the active component is present in the precise amount stated on the label.

Our hypodermatic tablets are of uniform strength. The content of each tablet is accurately determined, the medicament being uniformly subdivided by our method. The dose is invariable.

Our hypodermatic tablets are freely soluble. They dissolve completely in lukewarm water in a very few seconds. Test them by the watch!

Our hypodermatic tablets are stable. They are molded by a process that insures firmness. They do not crumble in shipping or handling.

TUBES OF 25—NOT 20.

Parke, Davis & Co.'s hypodermatic tablets are supplied in tubes of 25. Certain competing tablets are marketed in tubes of 20. Specify "Parke, Davis & Co." on your orders. Get 25 tablets to a tube, not 20.

Home Offices and Laboratories.
Detroit, Michigan

PARKÉ, DAVIS & CO.
A Nerve Sedative

and ideal adjunct in the preparatory treatment for

Anesthesia and Analgesia

Bromural relieves the restlessness and anxiety of the patients before anesthesia or analgesia. It helps to shorten the period of induction, to reduce the amount of anesthetic necessary and to diminish the after-effects. In nervous insomnia it creates the preliminaries for a healthy sleep.

Dose: 5 to 15 grains Bromural in powder or 5 grain tablets.
Abstracts and Clinical Notes on "Bromural in Anesthesia" upon request.

For full literature and samples of Bromural-Knoll apply to

KNOLL & CO., 45 JOHN STREET, NEW YORK

One Handle Only

Controls the flow and mixture of
N₂O and O on the

CLARK APPARATUS

Complete, as illustrated, with both Face and Nasal Inhalers, less cylinders, $75
Ready to Attach

Clark Vapor Warmer
Clark Ether Attachment
Clark Re-breathing Bag

SEND FOR OUR NEW CATALOG

A. C. CLARK & CO.

Grand Crossing CHICAGO, ILL.
Lukens

Oyloidin-Silk

Trade Mark.

Herewith is presented the ideal intestinal suture on needles for hollow visceras

ADVANTAGES

They have the well known strength of the cable being composed of smaller individual strand; Because of the peculiar body possessed by this strand it makes the safest knots and will not become readily tangled; Oyloidin, the composition with which they are impregnated, renders them absolutely non-capillary; The needle cannot possibly become unthreaded; They pass through the tissues with the greatest ease.

White or Iron Dyed
Sizes 1-2-3

C. DEWITT LUKENS CO.
ST. LOUIS, MO., U.S.A.

All Dealers. Samples upon request.

Lukens

Sterile Catgut

Trade Mark

The Standard in the World's Largest Clinics

BECAUSE

It is the highest development of the catgut ligature.

It is sterile, antiseptic, supple, elastic, strong, easily seen, will not untwist in using, and is more than usually resistant to absorption.

The only iodine catgut guaranteed against deterioration.

Sizes 00-4 Plain
Sizes 00-4 Tanned

C. DEWITT LUKENS CO.
ST. LOUIS, MO., U.S.A.

All Dealers. Samples upon request.

6,866 Major Surgical Operations were performed at a well-known Hospital in New York during the three years ending June 30th, 1915, and in not one case did a stitch abscess or other post-operative infection, attributable to catgut, occur. While the credit for this remarkable record is principally due to the splendid aseptic technic of the attending surgeons and their capable assistants, it is also worthy of note that "D & G" Catgut and Kangaroo Tendons were employed almost exclusively.

The varieties of catgut used were almost solely plain and Eleyday Chromic. (Twenty-day Chromic gut was seldom used.)

DAVIS & GECK, INC.

Surgical Instruments and Anesthetics Exclusively

CHARLES T. DAVIS, Pres.
CARRIUS H. WATSON, M.D., Director
ALLEN ROGERS, M.D., Chemist.

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22 South Oxford St.
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When writing, please mention ANNALS OF SURGERY.
Listerine is an efficient, non-toxic antiseptic of accurately determined and uniform antiseptic power, prepared in a form convenient for immediate use.

Composed of volatile and non-volatile substances, Listerine is a balsamic antiseptic, refreshing in its application, lasting in its effect.

It is a saturated solution of boric acid, reinforced by the antiseptic properties of ozoniferous oils.

After the volatile constituents have evaporated, a film of boric acid remains evenly distributed upon the surfaces to which Listerine has been applied.

There is no possibility of poisonous effect through the absorption of Listerine.

Listerine is unirritating, even when applied to the most delicate tissues; in its full strength it does not coagulate serous albumen.

For those purposes wherein a poisonous or corrosive disinfectant cannot be safely employed, Listerine is the most acceptable antiseptic for a physician’s prescription.

Listerine is particularly useful in the treatment of abnormal conditions of the mucosa, and admirably suited for a wash, gargle or douche in catarrhal conditions of the nose and throat.

In proper dilution, Listerine may be freely and continuously used without prejudicial effect, either by injection or spray, in all the natural cavities of the body.

Administered internally, Listerine is promptly effective in arresting the excessive fermentation of the contents of the stomach.

In the treatment of summer complaints of infants and children, Listerine is extensively prescribed in doses of 10 drops to a teaspoonful.

In febrile conditions, nothing is comparable to Listerine as a mouth wash; two or three drachms to four ounces of water.

“The Inhibitory Action of Listerine,” 128 pages descriptive of the antiseptic, may be had upon application to the manufacturers.
CLINICAL RESULTS WITH THE PHYLACOGENS

Under the above caption, Dr. R. W. Locher, Grafton, W. Va., in the Memphis Medical Monthly, has this to say: "In judging the therapeutic value of a new preparation, it is advisable that a great number of case reports be considered; and in order that the medical profession may have a great number of cases from which to judge, it is the duty of every physician to report such results as he may have. The Phylacogens are of comparatively recent origin, and yet even at this early date they have displayed their ability to produce satisfactory and in some cases remarkable results in the treatment of a great variety of pathological conditions. * * *

"We are informed that the Phylacogens are not claimed to be a 'cure-all' in any sense of the word, but simply valuable therapeutic agents in the treatment of numerous infectious conditions. From the very fact that all but Mixed Infection Phylacogen are to be directed against specific infections, it is necessary, before employing them, to make an accurate etiological diagnosis. For obvious reasons one cannot expect to produce results if Rheumatism Phylacogen is administered in a case that is really one of gonorrheal arthritis. Neither will an osteomyelitis or a syphilitic periostitis yield to Rheumatism Phylacogen, but the former may be logically treated with Mixed Infection Phylacogen. It would seem that this latter Phylacogen will ultimately prove of great value to the surgeon in combating post-operative infections, as well as infections following injuries of all kinds."

The writer then details fourteen case reports, covering a variety of diseases, and adds this by way of comment:

"From the foregoing cases it would be possible to draw numerous conclusions. What is especially striking, however, is that the Phylacogen treatment is apparently successful in the vast majority of cases and seems to give prompter and more definite results than is possible to secure with the usual recognized treatments. As a physician's experience increases he finds a greater number of cases in which each of the Phylacogens may be used, with the expectation of great benefit resulting therefrom. In any event, it must be conceded that Phylacogen in its various forms presents great possibilities and must be classed as a therapeutic agent which is more than worthy of trial."

VASO-MOTOR DERANGEMENTS

The part played by the vaso-motor system in countless diseases is at last thoroughly recognized. As a consequence, circulatory disorders are among the most common functional ailments that the modern physician is called upon to correct. Various heart tonics and stimulants are usually employed, but the effect of these is rarely more than temporary. To re-establish a circulatory equilibrium that offers real and substantial relief from the distressing symptoms that call most insistently for treatment requires a systematic building up of the whole body. Experience has shown that no remedy at the command of the profession is more serviceable in this direction than Gray's Glycerine Tonic Comp.

For nearly 20 years this standard tonic has filled an important place in the armamentarium of the country's leading physicians. Its therapeutic efficiency in restoring systemic vitality and thus overcoming functional disorders of the vaso-motor or circulator system is not the least of the qualities that account for its widespread use. The results, however, that can be accomplished in many cases of cardiac weakness have led many physicians to employ it almost as a routine remedy at the first sign of an embarrassed or flagging circulation.

Cleanliness of the genital tract is for women not only a valuable sanitary and hygienic measure, but also in many instances an absolute necessity, in order to prevent physical irritation or discomfort as well as mental unrest.

It is indeed a matter of common and daily experience that women who are nervous, irritable, easily worried, cross, peevish, moody, etc., are often greatly benefited by the use of warm or hot vaginal douches, properly employed by means of a suitable apparatus or syringe. The proper use of Marvel Whirling Spray Syringe is not only instrumental in the treatment of diseased conditions, but is also of great value as a prophylactic measure.

"I have not employed quinine and urea hydrochloride, but have followed the literature on its use, and I have yet to be convinced that it has any advantage over the drug I most employ, novocain—for local anesthesia." S. J. Youn, in American Journal of Surgery, Feb., 1912.
Ohio Monovalve No. 3
AUTOMATIC

THE most perfect and complete instrument made. Shown here with Face Inhaler and Tube attached and holding 2 cylinders of each kind of gas. The valves on two cylinders are opened full and so left without readjustment until the operation is over. The gases leave the containers at cylinder pressure and pass through the first pair of automats or regulators (one of which is seen in about the center of illustration), which automatically reduces the pressure. The gases then pass through the second set of automats (seen at top of illustration) and leave them at a pressure so low that when the rubber bags are full the flow from the cylinders stops until some of the gas is used. One valve permits the giving of nitrous oxid only, or of nitrous oxid with any percentage of oxygen or of oxygen only. When closed the gas stops passing to the patient and from the cylinders at the same time. By an easy and quick adjustment of the automats the bags can be kept partially filled or completely filled, and a positive pressure obtained. This apparatus is ideal for every sort of operation, long or short, where gas is the anesthetic. The flow is absolutely even, continuous and noiseless. The gas is utilized in the most economical way. Anesthetists in hospitals can give their full attention to the patient.

Write for Catalogue

THE OHIO CHEMICAL AND MFG. CO.
1177-1199 Marquette St. N. E. Cleveland, Ohio
DIGESTIVE FERMENTS

Presenting a gold medal, the highest award of the class, to Armour & Company for Digestive Ferments (Pepsin and Pancreatin) by the Committee of the International Medical Congress in London, August, 1913, was a universal appreciation of the high standard of the organotherapeutic agents emanating from a Laboratory with advantages that are apparent to a man of experience, who knows the necessity of putting raw material into process while it is perfectly fresh.

Thyroid, Suprarenal, Pituitary, Corpus Luteum, Parathyroid, Thymus, Spleen, Pepsin, Pancreatin and all products made from glands and membranes of animals should be prepared from absolutely fresh substances. Armour & Company offer all the gland preparations in powder and tablets, and in Pituitary Liquid furnish a solution of the active principle of the posterior portion of the hypophysis. Pituitary Liquid is clear, stable, and uniform, and is put up in 1-cc. ampoules, 6 to a box.

In discussing Lewen's method of anesthesia, Bryan, Journal Tennessee State Medical Assn., 1912, VI 240, notes the use of the following solution:

Sodii bicarb. C. P. (Merck) . . . 0.15
Sodii chlorat. ............... 0.1
Novocain .................. 0.60

Dissolve in 30 cc. of distilled water, to make a 2% solution. This method is almost uniformly productive of complete local anesthesia and has produced no deaths and no sequelae.

Stoeckel, of Germany, investigated sacral anesthesia for the amelioration of labor pains. His plan was to inject solutions of novocain varying in strength from 1-5 to 3% and in quantity from 3 cc. to 83 cc. To this was added a little suprarenin. He employed this method in 141 cases of labor and reported unquestionably favorable results in 111. The sacral pains were especially reduced, Bryan, in Journal Tennessee State Medical Assn., Oct., 1912.

"Bier uses local anesthesia if possible with novocain, one-half per cent. He does not often use spinal anesthesia, being so well satisfied with the local. I witnessed the removal of a kidney under local anesthesia." W. J. Mayo, in Journal Lancer, Aug. 15, 1912.

In preliminary ligation for exophthalmic goitre, by C. A. McWilliams, "the right superior thyroid vessels were tied on Aug. 5, 1908, using local anesthesia with a 3\% solution of novocain, combined with adrenalin, and without the preliminary use of morphine. No symptoms resulted from this procedure, nor was there any improvement in her condition, as was to be expected. Accordingly, 10 days later, the left superior thyroid vessels were similarly ligated, under the same local anesthetic. She immediately began to improve, mentally and physically, and in 7 weeks had gained 16 pounds." Proceedings of New York Surgical Society, May 8, 1912.

Riedel, of the Charlottenburg Hospital, Berlin, in writing on melubrin as an antipyretic and an antineuralgic (Ther. der Gegenwart, May, 1912), characterizes melubrin as an efficient antipyretic in pneumonia and endocarditis. Riedel's clinical experiences with melubrin revealed no collapses, exanthemates, or profuse perspiration, such as follow the use of the salicylates.

Mueller, of the Deaconness Hospital, Halle, (Wien. klin. Woch., 1912, No. 25), especially recommends melubrin as an antipyretic in acute and chronic polyarthritis and in pneumonia and sciatica.

Chetwood, of the New York Polyclinic, says that "an adequate course of salvarsan therapy is essential, following the initial dose, to complete the work that has been begun, and to effect the destruction of all the remaining active organisms."

"Children of 7 years and upwards may be given 0.3 gram salvarsan and 0.5 gram neosalvarsan, and the same proportion to the adult dosage followed with respect to the total amount." Chetwood, Practice of Urology, p. 794.

Loening, of the University of Heidelberg (Deutsch. med. Woch., 1912, Nos. 9, 10 and 11), says "Melubrin behaves as a specific in acute articular rheumatism. The remedy can even be used if endocarditis is present. It also gives positive results in chronic articular rheumatism, myositis and sciatica. I have given over 45,000 grains of melubrin and have seen no failures."

Schrenk, of the University of Heidelberg (Deutsch. med. Woch., 1912, No. 34), after using 2,500 grams on 60 patients, reports that "We were able to confirm the observations of Loening that one can cure articular rheumatism without salicylic acid preparations. We hold this to represent a very essential advance in medicine, for not every patient can tolerate salicylic acid, and a substitute then becomes absolutely necessary."
Ohio Monovalve No. 5
For Use with large Style F and G Cylinders

Ohio Monovalve No. 5 has every advantage of our No. 3 outfit except that it can not be conveniently used with small cylinders. The illustration shows apparatus connected to Style F Cylinders through Duplex Gauge Regulators which reduce the gas pressure to a few pounds. The large automatics on the Monovalve then cause a further reduction to breathing pressure. The valves on large cylinders are opened full and so left; if the bags become completely filled, the flow stops until some of the gas is consumed. Throughout the operation it is only necessary to turn one valve which permits giving Nitrous Oxid or Oxygen or any combination of both. The outfit as shown is ideal for a dental office. For hospital work it would be advisable to have the large cylinders on our Movable Stand. Warming Device with ether attachment as well as Re-breathing Bag can be attached to No. 5 Monovalve when desired.

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THE OHIO CHEMICAL AND MFG. CO.
1177-1199 Marquette St. N. E.
Cleveland, Ohio
OVER ONE HUNDRED YEARS AGO

The following curious advertisement appeared in a New York paper March 18, 1809, over a century ago:

Twenty Gallons of Nitrous Oxyd Gas, carefully prepared from the purest materials, will be exhibited this evening, for respiration and experiment, at No. 38 Dey Street, at 7 o'clock.

Tickets to be had at the door, 50 cents each.

For many years this gas remained a laboratory product, but as its value as an anesthetic became more widely known, the problem of placing it on the market as a commercial product was given increased consideration. It was found it could easily be liquified under pressure. Containers were then made by taking wrought iron pipe, cutting it into short lengths and welding in heads, but as the demand became greater a more satisfactory container was demanded and the modern cylinder of to-day is the result. This is neat and symmetrical, and without any more weight than necessary to thoroughly protect those who handle it. Progressive companies have welcomed regulations suggested by the Inter-State Commerce Commission resulting in a uniformity of strength and safety.

The attention given the purification of the gas has been even greater. Old methods consisted of passing the gas through numerous containers filled with various liquids which would ordinarily have a purifying effect, but careful analyses proved that slight impurities continued to exist and had a disturbing effect. It was found necessary to devise a more complete method of purification which resulted in the Tower system. This method causes the gas to slowly circulate through immense towers, permitting a large contact surface with the purifying fluids which constantly drop in the form of a spray or mist. The purification is so thorough and complete that this part of the apparatus has aptly become known as "The Scrubbers."

Probably the most modern plant in existence is that located in Cleveland where every known improvement has been installed. A complete machine shop is operated in connection with the chemical department for the purpose of manufacturing apparatus incidental to the use of nitrous oxid and oxygen.

This company was the first to adopt automatic regulation so that gas compressed in cylinders could be used conveniently and economically. Their device has become known as the "Monovalve" for the reason that one valve controls and mixes the gases. Before the operation the cylinder valves are opened wide and left in that condition. The automatic regulators and the one valve which has given the apparatus its name do the rest.

The Anesthetist of to-day has an advantage in being able to procure gas which can be depended on to be invariably pure, and obtain apparatus which enables him to administer it with greater precision and with correspondingly increased protection to the patients.

AN ALTERATIVE OF LONG SERVICE

It is mainly in chronic skin and glandular diseases that alteratives have found their most distinct field of usefulness, for these are conditions aggravated and continued by impaired nutrition and elimination, in the correction of which alteratives show what potent remedial forces they are. Among the alteratives IODIA (Battie) has long enjoyed professional favor and in this will be found a striking demonstration of its value, for no class of drugs are put to a more rigid test than alteratives, so its long continued use by physicians is the best evidence that it meets the demands made upon it. IODIA (Battle) will show its power in chronic skin diseases, glandular involvements and in other states indicating the corrective influence of an alterative agent. A distinct advantage offered by IODIA is that it may be continued over long periods without causing distress.

"KNUKLFIT" A NEW SURGEON'S GLOVE

From the rubber city of the world comes a new surgeon's glove, which, judging from its merits, will undoubtedly receive the endorsement of every surgeon.

The Hadfield Rubber Co. seem to have hit the bull's-eye by making the new glove with a bulge at the knuckles. This bulge permits free and easy action of the fingers, relieving tension at the tips and knuckles. That feature, with the pure fine Para rubber, gives the "Knuklfit" glove almost the normal surgical touch.

Of course the disadvantage in most surgeon's gloves, up to this time, has been the finger strain at tips and knuckles, which resulted in a false touch.

A full description of this new glove is given on page 25.
Ohio Nitrous Oxid
and Oxygen

Are worthy of the good things said about them by those who have investigated the merits of all gases and made comparisons of results.

Ohio Gas is manufactured at the most modern plant in the world. Every known improvement is utilized to insure a perfect product.

The highest authoritative analyses of Nitrous Oxid and Oxygen known to us are the following by Prof. Warren R. Smith, of Chicago:

<table>
<thead>
<tr>
<th>Ohio Nitrous Oxid</th>
<th>Ohio Oxygen</th>
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<tr>
<td>Nitrous Oxid</td>
<td>Oxygen</td>
</tr>
<tr>
<td>98.6 per cent</td>
<td>97.85 per cent</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>Nitrogen</td>
</tr>
<tr>
<td>1.2 per cent</td>
<td>2.16 per cent</td>
</tr>
<tr>
<td>Moisture</td>
<td>Carbon Di-oxine</td>
</tr>
<tr>
<td>.2 per cent</td>
<td>None</td>
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</tbody>
</table>

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1177-1199 Marquette St. N. E. Cleveland, Ohio

When writing, please mention ANNALS OF SURGERY.
COLLARGOLUM CONTINUES TO BE THE PREFERRED INJECTION MEDIUM IN SKIAGRAPHY AND URETERO-PYEOLOGraphY

While by far the greatest majority of American and European radiologists agree that Collargolum, which was first recommended by Voelcker and Von Lichtenberg in 1906 a, the most advantageous injection medium into the bladder and renal pelvis, has not been equalled technically by any other material since suggested for this purpose, occasional reports of alleged injury from its use have recently appeared in the literature.

W. F. Braasch of the Mayo Clinic, St. Mary's Hospital, Rochester, Minn., who was the first to extensively apply Voelcker and Von Lichtenberg's technique in the United States and has introduced many valuable modifications and diagnostic possibilities of the same, states in an article on "Recent Progress in Uretero-Pyelography" (Journal Mich. State Med. Soc., April, 1913) that this technique has been employed in the Mayo Clinic in more than one thousand cases without fatality or permanent injury. The occasionally observed colic following examination by this method was not more frequent nor more severe as after ureteral catheterization.

It has been his experience that severe reaction following pyelography, is usually the result of errors in technique or lack of care in the selection of the cases. In regard to the latter, careful perusal of Dr. Braasch's article is strongly recommended to all those interested, a short abstract being inadequate to do justice to this part of his report.

The following technical precautions are urged by him:

The Collargolum crystals should be carefully ground in a mortar when put into solution (10%) and the latter filtered, otherwise undissolved crystals may be deposited on the walls of the pelvis and ureter and act as an irritant. The solution should be carefully warmed before injecting, not boiled, since it coagulates with boiling. The solution should be injected by the gravity method, watching the patient for the slightest evidence of pain. From 2 to 8 cc. will usually suffice unless symptoms of obstruction have been previously noted. A large ureteral catheter should be used so that the injected solution may drain away easily. The apparatus for the X-Ray and the injection should be so arranged that there will be no delay after the catheter is inserted.

The unequalled diagnostic value of skia- graphy and uretero-pyelography by means of Collargolum and the innocuousness of the method if carried out correctly is also vouched for by Dr. George H. Stover, Prof. of Roentgenology, University of Colorado (Annals of Surgery, June, 1913; Dr. G. Strassmann, of the Surgical Polyclinic of Prof. F. Voelcker, Heidelberg Germany; Prof. Th. Nogier and Dr. J. Reynard, of the University of Lyons (Lyon Medical, 1912, No. 51); Dr. William I. Bruce, Radiologist to the Charing Cross and the Children's Hospital, London (British Medical Journal, Oct. 14th, 1911); Dr. E. M. Stanton, Schenectady, N. Y. (Albany Medical Annals, July, 1912); Dr. William T. Belfield, Prof. of Genito-Urinary Surgery, Rush Medical College (Journ. A. M. A., March 15, 1912); Dr. Lewis G. Cole, Clinical Professor of Radiology, New York Post Graduate Hospital (The Post Graduate, Jan., 1911); Dr. N. Nemenow, Chief of Central Roentgen Laboratory, St. Petersburg Medical High School for Women (Fortschr. auf dem. Geb. d. Roentgenstrahlen, Vol. 18, No. 3), and by a constantly growing number of other reports from nearly every civilized country.

THE GEBAUER INHALER FOR ETHYL CHLORIDE BY THE DROP METHOD

This Inhaler consists of a transparent shield with an exhaling valve, an opening for the introduction of Ethyl Chloride and a pneumatic rubber face pad. It is specially designed for administering Ethyl Chloride by the drop method and should be used with the 3 c.c. graduated dropper and Gebauer's Ethyl Chloride. The inhaler is closed sufficiently to confine the volatile vapor of Ethyl Chloride and yet encompasses the essential feature of allowing a proper amount of air.

The Gebauer Inhaler is built on scientific principles, simple of construction and most economical in the use of Ethyl Chloride. It is especially recommended for short operations and to induce narcosis preliminary to ether.

Dr. A. D. Bevan, in a discussion of Dr. C. H. Frazier's paper on Exposure of Structures at the Base of the Skull before the Mississippi Valley Medical Association, October 25, 1912, said: "Novocain has the advantage that it can be sterilized by repeated boiling without interfering with the strength of the solution. One can infiltrate the neck with an ounce of one-half per cent. novocain with great freedom from danger and in an ordinary case a much smaller amount than this is quite sufficient."
Electrically Lighted Surgical Instruments

Indispensable for accurate diagnostic and operative work. Fitted with superior Tungsten lamps, when specified, without extra charge.

MYRINGOSCOPE. Carroll
NASO-PHARYNGOSCOPE. Holmes
URETHROSCOPES. Young, Swinburne, Koch, Valentine
CYSTOSCOPES. Braasch, Lewis, Elster, Kelly
PHARYNGEAL, LARYNGEAL and OESOPHAGEAL SPECULA. Jackson
NASAL SPECULA
TONGUE DEPRESSORS
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PROCOTOSCOPES
TERINE ENDOSCOPE
TRANSILLUMINATORS
HEAD LAMPS
SOCKET CURRENT CONTROLLERS
SOCKET CAUTERY TRANSFORMERS

Supported by eminent physicians. Warranted mechanically and electrically perfect. All fully described in catalogue. Ask for it.

When writing be sure of our exact name
ELECTRO SURGICAL INSTRUMENT CO.
Rochester, N.Y.

ETHYL CHLORIDE C. P.
(Gebauer's)

ETHYL CHLORIDE C. P.
(Gebauer's)

for
Local and
General Anesthesia

The most improved and economical tube for the administration of Ethyl Chloride on the market. Extensively used as a preliminary to Ether in General Anesthesia.

40 grm. tube . $1.00
100 grm. tube . $1.60

Sent prepaid anywhere in the United States and Canada upon receipt of price.

The Gebauer Chemical Company
6963 Broadway
Cleveland, Ohio

Surgeons

Here's the Best Glove Made
Regardless of Price

THERE'S no question about that—absolutely none. Finer quality can't be put into a glove.

In "Knuklfit" Surgeons' Gloves we use the pure Para rubber. And this rubber is made immensely tough by our special formula.

They are tough as leather yet soft as baby's skin.

"Knuklfit"
Surgeons' Gloves
Give the Normal Surgical Touch

The patented knuckle gives free finger action—prevents all tension at tips—prevents all exertion.

Surgeons Endorse It

We have voluntary testimonials from many leading surgeons highly praising "Knuklfit" gloves. Order a pair by mail and try them. If they are not the best you ever had send them back and get your money.

"Knuklfit" gloves are rigidly guaranteed. Price, 75 cents a pair; $6.00 a dozen. Sizes 6 to 10.

Distributor Wanted

for "Knuklfit" in every city. Write now for our proposition and get the business in your city.

The Hadfield Rubber Co.
AKRON, OHIO

Everything in rubber. Surgeons' specialties made to special order.
PHENOL-SULPHONE-PHTHALEIN, RENAL FUNCTIONAL TEST

This drug has been utilized by Rowntree and Geraghty, Johns Hopkins Medical School and Hospital, to determine the functional capacity of the kidney in disease. By means of the test, which they have introduced, it is possible to determine accurately the condition of the kidneys, whether or not they are diseased and, in case they are, to determine the extent. This test permits one to determine whether the kidney disease, if chronic, will likely prove rapidly fatal, whether uremia is apt to develop or, if any given case is suitable for surgical interference from the renal point of view.

The use of the test enables one to select the most favorable time for operating. In cases exhibiting a continued suspiciously low output, the use of nitrous oxide gas, or spinal anesthesia, is suggested as preferable to ether, in order to protect the kidneys. When only a trace of the drug continues to be excreted, prostatectomy should not be attempted, even though the patient present no evidence of uremia. The test can be used to equal advantage preliminary to any surgical procedure, when it is deemed important to know the true functional capacity of the kidney.

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