otherwise, as the veins are much more developed at the side of the dura than directly in the middle line behind.

To secure perfect asepsis in the whole procedure is beyond everything absolutely necessary, but in the nature of things ought to be comparatively easy to any one realizing its importance. And among the many large series of cases operated on by skilled surgeons, in the aggregate including thousands of cases, errors in this respect are practically unknown. But it must be insisted on that the whole procedure demands on the part of those who would practise it both skill in and mastery of the details of asepsis. Moreover, in the use of the usual germicides for the sterilizing of the skin we have to take care that no trace of them be left on the surface which could be conveyed by the needle in any way into the spinal canal, where they are particularly undesirable from their irritating qualities. For the cleansing of instruments, etc., they are not required, and it is easy to sterilize the simple outfit by heat. The first point to be insisted on is that all needles, syringes, etc., to be employed for this procedure shall be kept apart in their own special metal box for this procedure, and for it alone. It will not do, for instance, to use a needle and syringe one day to aspirate an abscess, and the next for spinal anaesthesia, even though they be boiled; nor will it do to use them for morphine injections even, and then for our purpose. They must be set apart for the spinal puncture, and for that only. The same holds good of the little sterilizer in which they are boiled. This should never be used with any alkali whatever, as is done for general purposes. Any trace of an alkaline fluid remaining in needle or syringe would destroy the stovaine; moreover, soda solutions are particularly irritating if injected into the tissues. Distilled water or steam should be used for sterilizing purposes, and any water with a sediment should be rejected as injurious to the syringes with accurately-fitting pistons. It is also desirable to boil the outfits after each case, and finally to put them away aseptic in their own special box dried. The piston should not be put away in the syringe, but separately, and the same holds good of the stylets, otherwise they may be found to have jammed in drying.

The stovaine in solution, which is apparently antiseptic in itself, was in these cases taken from Billon's sealed glass "ampoules," which had been sterilized before fusing their ends at a temperature of 110° C. (=230° F.) for ten to fifteen minutes. These capsules were only opened a moment before use by breaking off one end, through which the needle was introduced. Such solutions and capsules should always be prepared by one with a large experience and skill in these matters. Overheating the drug or prolonging its sterilization too much renders it inert. As a matter of fact, all the ampoules were prepared for me by M. Billon, one of the coadjutors of M. Fourneau, the discoverer of stovaine, and his experience and knowledge of what is demanded is probably unequalled. Tablets are prepared containing all the ingredients of several compounds, but how they are sterilized is not mentioned. These are placed in the syringe, where they dissolve in the fluid which runs from the puncture needle, and this is reinjected. The results we shall be able to judge of in time, and if found safe and satisfactory this method of preparing the solution will have some advantages.

The skin of the lumbar area is carefully cleansed beforehand by repeated washings with very hot water, soap, and brush. After this come compresses of the usual antiseptics for some hours if possible. A moment before the puncture the skin is washed with normal saline to remove any traces of bichloride, carbolic solution, or spirit which may remain on it, and which might possibly be carried by the needle into the sac. All these precautions, carried out rigorously, are necessary in every case, and with them the chances of infection of the canal are remote indeed. They would be considered sufficient for many much larger operations done every day upon the brain and spine.

This report originated in a desire on the part of the writer to fairly test the value of a procedure which has been now for more than eight years attracting much attention. This has naturally led to an examination of the theories and conclusions of those who originated and elaborated the method and practised it with the most praiseworthy caution in large series of cases. Reflection on these and on the work of others who followed has

aroused a doubt here and there as to the correctness of some of the conclusions arrived at so far, and suggested explanations of some of the phenomena connected with the procedure which are not in accord with views held hitherto. It is hoped that these suggestions may be tested, and if found unsound rejected. They will at all events have called attention to some points not yet clear, and perhaps paved the way for further and more fruitful inquiry.

Since this paper was drafted some months ago, some 28 cases have been added to our list, and have only fortified the conclusions here stated.

INFILTRATION ANAESTHESIA IN MAJOR AND MINOR SURGERY.*

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For some years I have been interested in local infiltration anaesthesia, or rather analgesia, and my experience of the method leads me to believe that in this country surgical operations are too infrequently performed with its help.

We owe our knowledge of infiltration anaesthesia as a substitute for general anaesthesia almost entirely to Continental and American surgeons, but the few recent papers by British writers, although not marked by much originality, have served to call attention to the good results attained by the method.

The term "infiltration anaesthesia" is far from signifying the haphazard subcutaneous injection of a solution of cocaine or eucaine with a view to rendering painless some trivial proceeding of minor surgery. Local anaesthesia of this kind is inefficient and dangerous, sometimes even fatal, owing to the toxicity of cocaine.

Connell¹ states that out of 250 reported cases of cocaine poisoning 13 terminated fatally. The subcutaneous injection of a solution of indifferent strength is painful in itself, and may be followed by sloughing of the tissues, a point to which I shall again refer.

In 1899, Schleich of Vienna introduced infiltration anaesthesia. Next to the pioneer work of Schleich and to the discovery of other agents less toxic than cocaine, the advancement of local anaesthesia is probably most indebted to Dr. Takamine, the discoverer of adrenalin. Braun of Leipzig first suggested the addition of this substance to solutions used for infiltration anaesthesia. The essential desiderata of such solutions may be summarized under three headings:

1. The percentage of the active agent contained in the solution must be sufficiently high to render the fluid efficient as an anaesthetic, but the total quantity of fluid infiltrated from beginning to end of an operation must contain an amount of the active agent insufficient to give rise to toxic results. As a corollary, it follows that solutions of cocaine are inadmissible unless only a small quantity of fluid be required, since it is not safe to inject more than about $\frac{1}{4}$ gr. of this substance.

2. The solution must be sterile, which is nearly equivalent to saying that its active agent should be capable of being boiled without impairment of its anaesthetic properties.

3. The third essential of the solution on which stress must be laid concerns its physical and physiological features. It must be as nearly as possible isotonic with the tissues.

In specific gravity, freezing point and osmotic pressure, it must correspond with the tissues. Solutions either too concentrated or too weak will be painful when injected, and are liable to cause destructive changes in the tissue cells, which may be followed by necrosis and sloughing. Such untoward results have not infrequently followed the injection of an-isotonic solutions. Sodium chloride is common to every infiltration solution, which should be no more destructive by its local effects on the tissues than normal saline. The salt is added in correct proportion to render the solution isotonic.

The addition of adrenalin chloride or its equivalent under another name, such as suprarenin, reneglandin, hemisine, etc., in the proportion of one part in 100,000 is a manifest gain. It acts as a powerful capillary haemo-

* Amplified from a paper read before the South-Western Branch of the British Medical Association.

static, blanching the tissues, delaying the local circulation and consequent absorption of the anaesthetic; its action is consequently prolonged, and much less solution is needed. Solutions containing adrenalin must be freshly prepared, as exposure to air causes oxidation, the solution turns a brownish colour, and the properties of the adrenalin are lost.

We are indebted to some of the large manufacturing chemists for the way they have facilitated the preparation of fresh sterile isotonic and active solutions. A sterile tablet or powder is dissolved in a measured quantity of sterile water. More simple still, we can buy the sterilized solution ready for use.

I have always used either eucaine hydrochloride or novocain in large operations under infiltration anaesthesia. Novocain is probably the better, and has been largely used by Professor Braun. It has a low toxicity, as much as $\frac{1}{2}$ gram being without danger; and this quantity, approximately $7\frac{1}{2}$ gr., is contained in 100 c.cm. of the isotonic novocain suprarenin solution recommended by Braun. Such a large quantity as 100 c.cm. can seldom be required for one operation; but where a large volume of fluid is required, Braun's $\frac{1}{2}$ per cent. solution may be diluted with an equal volume of physiological salt solution. Sterile solutions made to Professor Braun's formula can now be obtained in hermetically sealed phials. Each 25 c.cm. of the solution contains:

Novocain	0.125 gram.
Suprarenin borate	0.0016 "
Sodium chloride	0.225 "

I have known the skin quite insensitive to a large needle as long as four hours after an infiltration operation with this $\frac{1}{2}$ per cent. isotonic novocain suprarenin solution; tactile sensation to a certain degree is not abolished, the method, therefore, does not result in a true anaesthesia.

Infiltration is carried out with an all-glass syringe furnished with some fine really sharp hollow needles. It is convenient to use a syringe holding more than the ordinary hypodermic syringe; syringe and needles should be boiled in plain water, or if placed in the sterilizer with the instruments, all traces of soda should be removed by syringing with sterile water free from any alkali. Syringe and needles when not in use should be kept during the operation in a vessel containing plain water.

The line of incision having been marked out by the eye, a probe is dipped in liquid phenol and the adhering droplet transferred to the skin at the point where the incision is to commence. Minute carbolic droplets are similarly placed at intervals of $\frac{1}{4}$ in. along the whole line of the intended incision, and, in fact, a little beyond both of its extremities. The phenol droplets mark the point of insertion of the needle and serve to sterilize and anaesthetize the skin, so that the patient does not feel the pain of insertion. The operator then proceeds to infiltrate the dermis, the needle being inserted nearly parallel with the surface with its aperture pointing upwards. The little pale wheals which are thus made to appear at intervals of half an inch by this process of oedematization of the skin overlap each other at their contiguous margins. If these wheals are not seen, it shows that the solution has not been injected endermically, but has entered hypodermically, and the injection should be repeated, for, unless this artificial oedema of the dermis is produced, the patient will feel as pain the cut of the knife. Within two minutes the skin may be freely divided with absolutely no pain, and the deeper tissues are then methodically infiltrated, after which the operation is proceeded with. Slight pauses are necessary from time to time to allow the infiltrating medium time to act on the nerve branches and their terminations. The slight additional time taken up by the operation is of no moment from the point of view of the welfare of the patient, and the operator is free from the anxiety which the element of time carries with it in operations under general anaesthesia.

No dietetic limitations are necessary in anticipation of an operation under local infiltration anaesthesia. Sometimes, a few minutes beforehand, $\frac{1}{2}$ gr. or less of morphine subcutaneously may be given with advantage for its tranquillizing effects, and not infrequently $\frac{1}{2}$ oz. of brandy in a little milk or water by the mouth is grateful to the patient in a tedious or trying case.

Coeliotomy can be performed painlessly under infiltration. I have done five abdominal sections without a general anaesthetic. The limiting factor in abdominal

work being, as might be expected, the fact that forcible retraction of the abdominal wound and traction on the hollow viscera will be resented by the patient. Bowel can be cut or sutured with little or no pain without anaesthesia of any kind, but traction on the peritoneum or mesentery by stretching nerves not under the influence of the local anaesthetic is painful in proportion to its degree.

In many acute abdominal cases and in strangulated hernia the condition of the patient is so bad at the time of the operation that the immediate risk of general narcosis becomes exceedingly great. Post-anaesthetic vomiting, also, in these cases may result fatally in otherwise successful operations.

Avoidance of prolonged general anaesthesia being of the utmost importance in surgery of this class, a field is opened up for local infiltration, or for infiltration followed if necessary by the inhalation of a minimum amount of chloroform or ether.

Operations on the subjects of advanced pulmonary and cardiac disease and in the elderly and feeble, unjustifiable under general narcosis, may often be carried out by the aid of the method under consideration.

Kocher has shown that local anaesthesia is almost a *sine qua non* in operation for thyroid enlargements and growths in the neck where there is tracheal compression. The advantage of employing this method in some cases of tracheotomy has also recently been pointed out by Dr. StClair Thomson.

My own list of operations under infiltration include the following:

- Gastrostomy (by the Seabanejew-Frank method).
- Herniotomy (three cases); appendectomy in a quiet interval.
- Laparotomy for intestinal obstruction.
- Laparotomy with resection of small intestine and end-to-end anastomosis.
- Suprapubic cystotomy.
- Closure of an artificial anus (preliminary colostomy).
- Radical cure of hernia.
- Radical cure of varicocele.
- Removal of a mass of suppurating tuberculous glands in the groin (in an old and debilitated patient).
- Extirpation of the saphena vein in the thigh and its tributaries in the leg for varix (many cases).
- Numerous minor operations for the removal of cysts, lipomata, needles, etc.

The Case of Gastrostomy.

The patient was a woman admitted to the Torbay Hospital in 1903 with malignant stricture of the oesophagus. She was emaciated to the last degree and in an extremely weak and starved condition owing to her inability to take any food by the mouth. At the conclusion of the operation and whilst the patient was still on the table I introduced by way of the gastrostomy a pint of warm milk and eggs—to her immense satisfaction. This, of course, could not have been successfully done so soon had a general anaesthetic been administered. The patient increased in weight and strength after the operation, but succumbed to the progress of the disease one year later.

It is important when employing infiltration analgesia to work gently and without too much haste. The tissues in the field of operation should be thoroughly analgesic. The simple operation for varix affords an example. By the production of an artificial oedema of the dermis in the manner described the skin over the course of the saphena in the thigh is divided with a gratifying freedom from discomfort to the patient, who is probably unaware of what has taken place. The temptation then is to proceed too rapidly with an insufficient infiltration of the remaining structures, and consequently some quite avoidable pain may be inflicted. On the other hand, care should be taken to envelop the superficial nerves and the vein itself in an anaesthetic atmosphere by further injections of fluid, followed by a short pause before proceeding to the ligation and extirpation of the vein.

The main advantage gained by operating under local infiltration anaesthesia instead of under general narcosis lies in the greater safety of the patient. To operate under a local anaesthetic is probably to operate under the safest known conditions. No special preparation of the patient is necessary. There is no after-vomiting or other ill result or discomfort due to the anaesthetic. One less assistant is required—namely, the anaesthetist.

It would be idle to say more in favour of the method for minor operative work, but what I think should be emphasized is the great value of infiltration anaesthesia in the case of many large surgical procedures.

To operate on a conscious patient is often undoubtedly to impose on the subject a certain degree of strain and fear, but in patients who are not acutely ill at the time, even in nervous and highly-strung individuals, the objection to infiltration anaesthesia on this score is of surprisingly little moment, and it is a pleasure to observe such patients comfortably enjoying a meal immediately on their return to bed. As a further set-off to this objection, the great and not altogether unreasonable dread of a general anaesthetic, which exists so prominently in a large proportion of patients, is to be borne in mind.

Infiltration anaesthesia occupies an unimportant position in the surgery of to-day, at least in this country. In the surgery of to-morrow I believe it will hold a different place.

The further developments of local anaesthesia in the form of medullary anaesthesia and regional anaesthesia produced by infiltration of large nerve trunks with stronger solutions are beyond the scope of this short paper, but in this connexion attention may be drawn again to the important researches of Crile² and Cushing³ in America. These experiments have demonstrated that the cocaineization of large nerve trunks supplying the field of operation, by blocking the transmission of centripetal impulses which would otherwise bring about reflex loss of vascular tone, abolishes what is probably the main cause of the phenomenon of shock.

By a combination of regional anaesthesia of the great nerve trunks and local infiltration at the seat of operation major amputations can be performed without general narcosis.

The regional anaesthesia produced by the injection of the anterior crural below Poupart's ligament enables Thiersch's grafts to be taken from the front of the thigh. It seems probable that Tagliacotian operations might be undertaken by a similar combination or by local infiltration alone, which would give the important advantage of the co-operation of a conscious patient.

REFERENCES.

- ¹ Connell, *Annals of Surgery*, vol. ii, 1903. ² Problems Relating to Surgical Operations. ³ Cushing, *Annals of Surgery*, vol. ii, 1902.

An Address

ON

CHOLELITHIASIS.

DELIVERED BEFORE THE STOCKPORT MEDICAL SOCIETY,
JANUARY 10TH, 1907.

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[AFTER some introductory observations Mr. Stanmore Bishop said:]

Confining ourselves only to our present subject, gall stones, it is to be noted that attention is no longer concentrated upon these concretions alone. These bodies, wherever found, whether in the gall bladder or in the ducts, are now recognized as being only part of a more general condition; a very important, perhaps from the patient's point of view the most important, factor, but not the only one, and except in certain cases, where their mere mechanical position renders them exceptionally harmful, not the most dangerous factor. The eye of the clinician seeks rather to discover the condition of the biliary channels which contain them, and the physician is as much concerned to know the specific organisms with which he has to deal as to witness the removal of the results of their agency.

It has been commonly received as an accepted fact since the writings of Kehr that only 5 per cent. of the persons whose biliary passages contain calculi develop during life any symptoms which call attention to this region. If by such symptoms the ordinary well-marked attacks of biliary colic are understood, this statement is probably near the truth, but subsequent research has shown that the presence of biliary calculi may be responsible for many conditions which in olden times were vaguely described as "stomach trouble," "windy spasms," "indigestion," "biliousness," or even "neurosis," and were indiscriminately referred to some functional disorder of the

stomach. As a consequence, many patients who later developed well-marked biliary colic only came for operation when the changes in the gall bladder and ducts had been in existence for years and were already complicated by alterations, local and general, which greatly accentuated the danger of the surgical interference itself, and effectually prevented the ideal return to the normal condition at which almost all surgical measures in the abdomen aim. The increased knowledge though, as I said, far from being complete, is rapidly enabling the surgeon to interfere earlier, and, consequently, to better purpose.

It is now accepted as a well-recognized fact that the essential condition which underlies all cases of cholelithiasis, whether accompanied by symptoms which cause its recognition during life or not, is a catarrhal inflammation of the biliary passages due to infection from certain micro-organisms, and that the most frequent of these are the *Bacillus typhosus* and the *Bacillus coli communis*. Other organisms have been found, but in much smaller numbers.

This infection may reach the channels implicated in one of four ways: (1) Through the duodenal opening, (2) through the portal circulation, (3) through the systemic circulation, (4) through the lymphatic circulation.

At first sight the duodenal opening would appear to be the most likely avenue of infection; there is a direct continuity of lining mucosa between the two channels of the small intestine and the common duct; the intestine is the natural habitat of the two micro-organisms most frequently encountered; from time to time the opening between the two is patent. But certain facts throw considerable doubt upon this theory.

1. Virulent organisms such as would be found in the intestine do not cause the formation of gall stones; the effect of their presence is rather to produce the more acute inflammatory changes which determine phlegmonous cholecystitis, gangrene of the gall bladder, ulceration and perforation. For the formation of concretions a certain attenuation of the micro organism appears to be necessary. Mignot showed¹ that it was the milder catarrhal inflammations which were accompanied by calculous formation. A. Ewald also, in 1903, demonstrated the same fact.

2. Although the intestine as a whole is the habitat of the bacilli in question, the duodenum, as several observers have pointed out, is singularly free from them.

3. When the duodenal opening is patent, there is a free flow of bile through it. Although it has been shown that organisms of this character will grow readily in bile, they would be far more likely to be washed away from the edges of this opening into the intestine than to ascend against the discharging current.

4. If micro-organisms ascend in this way, why are not inflammatory disorders of the pancreatic duct as frequent as those of the biliary channels? The opening of the one duct is as accessible from the common diverticulum of Vater as the other.

So that the probability of such an infection as would lead to the formation of biliary calculi reaching the biliary channels by this route would seem to be gravely discounted. At the same time it must not be understood that this is denied. Lippmann² has isolated bacteria from the common duct in numbers decreasing upwards. Kelly³ says that in presence of gall stones, bacteria are not infrequently more numerous in the lower end of the common bile duct than elsewhere in the biliary tract, and that these are the motile much more commonly than the non-motile organisms.

That an attenuated infection, such as would give rise to calculous formation, will reach these channels by way of the portal vein is much more probable; and the information, mainly obtained by operative work and by experiments on animals, which supports this statement has, at the same time, considerably altered the view taken of the function of the liver itself.

Lately, owing chiefly to the work of the Italian-school of physiologists—Semmola, d'Amore, Geoffredi, Falcone, and Boccardi—the view that one of the functions of the liver is protective has been enlarged and emphasized until now, without denying its action in the production of glycogen, and the other already known facts concerning it, the tendency of modern thought is to look upon it as, in fact, the great toxin filter of the body; by its action the numerous toxins introduced in the food, or produced in the small intestine by the various fermentations and