should be considered on his own merits irrespective of the name of the affection with which he was troubled. If this work be worth doing, it is worth doing well; it would require a great amount of care and much responsibility on the part of the medical examiner. This would necessarily demand extra remuneration, and might raise the importance of the medical referee even up to that of the actuary. I am not going to tell you what I would consider fair rating for particular diseases or individuals, because the matter is not yet under consideration, and the value of my advice has not been assessed. However, I shall broadly tell you some diseases at which actuaries and some medical referees look askance, but in which, in my opinion, a large and profitable business might be transacted. On this list I would place heart disease at the top. Many an individual lives after a heart affection has been discovered twenty, thirty, or forty years, and dies of some other disease. Surely this should be good enough for an insurance company, but here the judgement of the medical examiner would be a matter of vital importance, and great care would require to be taken to draw a distinction between lesions following rheumatic fever and those of a degenerative character, as well as the physical effects of the particular lesion. Certain diseases of the kidneys also run a very chronic course, but here great care would have to be exercised as to the functional capacity of the kidneys, the habits, diet, and surroundings of the applicant. Frequent attacks of quinsy and rheumatic fever should be rated up, even though no heart mischief has resulted. Chronic otitis media might be accepted at a moderate rating if the middle ear and mastoid cells have been cleared out. Many cases of healed tuberculous disease of the skin, glands, and bones might be accepted at a moderate increase, but all cases of healed tuberculous lesions of the lungs require a high rating until the individual has paid sufficient premiums to get rid of the risk of the company. Syphilis would have to be individually judged by the effects, and in all cases the company should insist on a prolonged course of treatment. Glycosuria occurring in persons over 40 years of age need not be a complete bar to insurance, but the rating should be moderately high.

Old pleuritic adhesions, chronic bronchitis, emphysema, and asthma might be accepted if the vital capacity was not much reduced below the normal, but in all such cases the premiums should be high.

A previous history of diseases of the digestive system would have to be considered on the merits of the individual case. The Americans are apt to look upon a person who has had his appendix removed as an improved life, one of the danger signals removed from their risks, but I am somewhat sceptical. Although I do not attach any grave importance to the matter, I am of the opinion that the individual who has been foolish enough to get appendicitis is apt to get other affections of his colon. A small addition will suffice for hernia if an effective truss is worn. Bad teeth, a previous history of gastritis, haematemesis, peritonitis, colitis, gall stones, etc., should only be accepted with a considerable addition to the ordinary premium.

Myxoedema, being a disease very amenable to treatment, may be accepted with a moderate addition, but exophthalmic goitre should have a high rating. Diseases of the kidneys, stricture of the urethra, and renal calculus require careful consideration, and the last two should be deferred until after operation.

UNINSURABLE LIVES.

The following conditions should exclude from insurance unless, perhaps, at something like prohibitive rates: Any acute illness with a high mortality until the danger has passed, all forms of active tuberculous mischief, malignant disease, diabetes in the young, Addison's disease, leucocythaemia, splenic anaemia and lymphadenoma, insanity and all advanced diseases of the nervous system, advanced degenerative lesions of the heart and blood vessels, all diseases of the lungs when the vital capacity is reduced below two-thirds of the normal, chronic alcoholism, etc.

In conclusion, gentlemen, I may say that I look upon life insurance as a sound and safe investment, and I should like to see its beneficent advantages more widely diffused among the community. Such investments will enable many to escape the pitfalls which are laid for the unwary by scheming company promoters and other

scoundrels. Insurance, to be successful and give uniformly good results, should be conducted on sound business and scientific lines, and the gambling element should as far as possible be eliminated. You are engaged in a good work, and I wish you all success.

A Second Report

ON

CLINICAL EXPERIENCES WITH SPINAL ANALGESIA:

WITH

A SECOND SERIES OF ONE HUNDRED CASES.

By ARTHUR E. BARKER, F.R.C.S.,

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WITH no wish on the one hand to advocate or, on the other hand, to disparage this new procedure, I have hopes that the following study may help to settle its proper value in surgery, whether this be small or great.

A report on my first hundred cases has already appeared in this JOURNAL on March 23rd, 1907. To this were added some reflections on the procedure based upon personal experiences and the writings of numerous other observers. Some experimental work of my own in a new direction was also noticed, which, as it had helped towards increasing uniformity of results, it was believed might be of use to others. Next to freedom from risk, *certainly* and *uniformity* of effect and diminution in the frequency of, or entire immunity from, such passing sequelae as headache and sickness are the most important problems which confront us. In the analysis of this second series it will be seen that in this direction much progress has been made as contrasted with the first hundred. As to possible risks, they have been surmounted in both series, and there are no serious untoward effects in either to be reported due to the procedure.* The greater uniformity in the anaesthesia I believe to be due, apart from improved manual skill, to a fuller appreciation of the part which *gravity* may be made to play on the drug injected into the lumbar dural sac, and the limitation of its action as far as possible to particular areas of the spinal canal. The same may be said of the occasional sequelae, vomiting and headache. There appear good grounds for the belief that they are prevented or mitigated by the exclusion of the drug as far or as long as possible from the cranial cavity. How this localization was effected is set out in my first paper, and I have nothing to add to the principles there advocated based on experimental work done early in 1906, and also there recorded. But it may be added that the more I and those gentlemen who have given me their intelligent assistance during operations have seen of the practice based upon them the more we have been convinced of their correctness. But it is only fair to say that these principles of action are diametrically opposed to those laid down by our Continental *cofrères*, who are entitled by large experience and research to speak with authority. Dönitz, for instance, who may be regarded as the chief exponent of the views of the Bonn Klinik, which under the leadership of Bler has done more than any other surgical centre hitherto in the investigation of the anatomical and physiological sides of the procedure, has, in a paper which only came into my hands after my first essay was published, expressed views and come to conclusions quite at variance with those which I ventured to put forward in it, and which appear to me now more than ever correct as the result of much larger experience. From most of his anatomical and physiological facts few would dissent. But in the practical conclusions which he draws from them, and in his absolute repudiation of some of the *physical* factors which play a part in the procedure, there is, I think, much to be questioned. This is to be regretted; for in his denial of the effects of gravity, for

* The error of calling this a puncture of the cord is constantly made, and has aroused exaggerated apprehensions. It is merely a puncture of the dura at a point well below the termination of the spinal cord.

instance, he is (speaking with the authority of long study and large experience) directing the attention of operators away from a factor which, properly appreciated, may largely affect the simplification, the success, and the safety of the procedure in many ways.

His position is best stated in his own words.¹ Having referred to the possible errors of technique in the puncture of the lumbar sac, he says:

But even where the injection has been correctly done there are a number of factors which influence the extension upwards of the analgesia. These are (1) the change of position of the patient *subsequently*. (2) The condition of the blood pressure within the skull. (3) The amount of the solvent used with the anaesthetic agent. For the sake of completeness it may be stated also that larger doses of the agent produce higher anaesthesias and that the absolute volume of the *liquor cerebri* present in the canal must also play a part. *But with these the knowledge of the determining factors is exhausted. (The italics are my own.)*

The positions in which the patient is placed after injection have the most important influence upon the extension upwards of the anaesthesia. A comparison of these may be made, taking only three varieties for the sake of brevity.

1. Injection with the patient lying down on the side and remaining horizontal.

2. Injection in the sitting posture, the patient subsequently lying on the back.

3. Injection in the sitting position followed by great elevation of the pelvis.

With the first of these we find the lowest, with second a higher, and with the third the highest extension upwards of the anaesthesia. The cause of the difference is very simple. If the horizontal position is changed into the sitting, the *liquor cerebri* runs out of the cranial cavity into the spinal canal. If the patient again lies down, the fluid runs back once more into the skull. When the Trendelenburg position is produced, a still larger amount of the cerebro-spinal fluid flows towards the head. Seeing that the analgesic compound injected is carried with the spinal fluid, the extension of the analgesia upwards or downwards is determined by its movement. *It is not a question of the action of gravity on the analgesic compound at all, nor is it one of hypothetical currents.*

Every one of these conclusions I am prepared to traverse on theoretical grounds and by practical demonstration on the living patient *if heavy injection compounds be used*. Again, and to this he attributes much importance:

It is not a question of diffusion. It is simply one of shifting of the balance in the liquor spinalis which takes place at the moment of the change of posture.

In these words Dönitz defines the position of his school beyond all possibility of being misunderstood. His views have had a great currency on the Continent, and may be said to be so far universally accepted in Germany. But it must be remembered that all Bier's followers worked with fluids of low specific gravity (see my first paper of March 23rd, 1907).

Now, without denying that an analgesic compound of low specific gravity injected into the lumbar sac may be carried upwards or downwards to a large extent by the movements of the whole column of cerebro-spinal fluid, we may well ask ourselves whether this is the best and, as Dönitz asserts, the only way in which the agent employed can be made to operate above the point of injection. I venture to think that *it is not the best way*, and have proved, experimentally first and then in clinical practice, that *it is not the only way*. These conclusions are based, therefore, not only on theoretical grounds supported by physical experiments alluded to in my last paper, but

on the experience now of a sufficient number of cases to test their accuracy. That the best way of attaining a high anaesthesia is to wash the injected compound upwards in the spinal fluid by elevation of the pelvis with the certainty of its being diffused more or less through the latter as it passed through the nerve roots, and the uncertainty as to the height it will reach to, can hardly be claimed. Moreover, this mixing and diffusion reduces the concentration of the drug, and more of it is required than if a smaller quantity is applied to a given area. But though the compound injected may beyond doubt be shifted with the spinal fluid towards the head by the means which Dönitz advocates, and perhaps with impunity, the question remains, Is there no better way? I venture to maintain that there is, and that wherever it is employed it will lead to greater accuracy in using the method, and to more certainty and uniformity of results with smaller doses of the drugs in vogue than those measures hitherto practised. If this be so, and adequate anaesthesia can be produced *with relatively small doses*, the intrinsic risks from the action of the drug ought to be reduced. What these toxic risks are it is at present impossible to say in figures, but they appear small when the procedure has been in skilled hands. As to possible remote effects on the nervous structures, the evidence so far is negative, as those surgeons have pointed out who have seen large numbers of their cases years after operation. Bier, at all events, who began this new procedure in 1898 and who was one of the first men in Europe upon whom lumbar anaesthesia was practised, has, we are all glad to know, shown the greatest physical and mental vigour ever since, albeit the immediate specific effects of cocaine which he then used were unmistakably severe in the shape of sickness and very bad headache lasting for many days. But though there may be certain risks connected with the procedure, as there are with the use of many other fully recognized and widely used drugs, we must remember that spinal analgesia has

probably already saved the lives of many patients whose condition at the time of operation would have almost certainly precluded the employment of general anaesthetics. This aspect of the matter seems to be often overlooked. The profession and the public are quite alive to the fact that there are dangers from general anaesthesia both immediate and remote. It may be that in spinal analgesia we have the means of avoiding some of these. But this can only be settled by serious study and experience; to speculate without these in such a matter seems idle.

The means employed in these two series of cases during the past two years to effect the ends in view are to make use of *gravity* (the very force which Dönitz repudiates) acting upon an injection compound of much greater specific weight than that of the *liquor spinalis*. This has already been demonstrated in my former paper, where the specific gravities of the various compounds employed are worked out in detail.

It now remains to show how our practical experience bears out the above conclusions. As regards the limitation to the lowest intradural nerve roots, we have found throughout the whole series that when injection was done in the sitting position (Fig. 1), the patient subsequently lying quietly down with the head and shoulders well raised, the analgesia was confined

Fig. 1.—Sitting position for puncture when analgesia of the perineum is required. The line from iliac crest to crest crosses the fourth lumbar spinous process, above which the needle is entered. The patient is then gently laid on his back with the head and neck well raised, all unnecessary movement being avoided. (From a photograph by Dr. E. Worrall.)

altogether to the perineum and sometimes the lower limbs. For instance, in cases of piles, while the patient was being operated on in the lithotomy position sensation was absolutely lost in the perineum, while motion remained in the legs and feet in many cases. Here the heavy analgesic compound ran down into the sacral dura and remained about the sacral plexus until absorbed. In this case there could be no question of movement of the whole column of the liquor spinalis upwards until a segmental paralysis was produced. The experiments *in vitro* (vide former paper) prove this, also Fig. 2, A, in text.

Again, we have demonstrated in many cases that if the patient is laid on his side with the head and neck well raised (Fig. 3) before injection in the second lumbar space, and is then turned quietly over on his back (Fig. 4), the pelvis remaining in the same relation to the neck as before, analgesia in five minutes reached to the sixth or seventh dorsal roots or higher. This all means simply that the heavy fluid containing the drug flowed from the highest point of the lumbar curve (point of puncture) to the lowest in the lateral or dorsal depression by virtue of its specific gravity (1.0230), the liquor spinalis (specific gravity 1.0070) being in a state of rest (Figs. 3 and 2, C, and Fig. 4).

But if any other proof were needed of the behaviour of our heavy analgesic fluid in the canal, it is furnished by those cases in which we have kept the patient on the side from before the injection to the end of the operation without any change of position at all. One or two cases out of many will suffice. It was necessary to amputate a young man's left leg below the knee. He was laid on the left side with the head well raised on pillows, the left shoulder resting on the table. In this position, which was not altered in the least until he left the table, the injection was done in the second lumbar interspace (Fig. 3). In the course of five or six minutes paralysis of sensation was absolute in the dependent left leg. In the right leg motion was never lost at all. The patient was quite comfortable throughout the amputation. In another case of operation for varicose veins of the left thigh and leg, the same was done, and with the like result. Dr. Henry Head, who was present, and was kind enough to test the phenomena of sensation and motion most minutely, stated that the right (upper) thigh and leg remained entirely unaffected both as to sensation and motion. This can only be explained by the flow of our heavy analgesic compound along the roots of the lumbar nerves of the left side without any diffusion. It certainly was not segmental by diffusion, as the functions of the other limb remained unaffected throughout. It would be incorrect, then, to call this medullary anaesthesia, as is sometimes done. But in patients thus injected on the side with the shoulder resting on the table and the head well raised, we have seen a one-sided analgesia extending up to the middle of the thorax passing into a bilateral soon after they have been quietly rolled over on the back without any alteration of

the relative levels of head and pelvis (Fig. 4). This simply means, as has been demonstrated *in vitro* (Fig. 2, B and C), that the fluid "pooled" in the most dependent part of the dorsal curve has gravitated across to the roots on the opposite side as soon as the patient lay on the back. A medical man recently operated on lying in the same position on the right side without change became anaesthetized up to the second rib, and was quite comfortable while I explored his right kidney. He stated spontaneously that the effect of the stovaine was rather pleasant after the first prick of the needle, which was like that of an ordinary hypodermic injection.

It is clear, then, that we can make use of the specific gravity of our heavy injection to produce either a high or low anaesthesia, by carefully adjusting the curves of the spine beforehand to suit our purpose, and without subsequently changing its level. We can even produce a one-sided insensibility if we desire, though in those cases mentioned it was only done to test the correctness of our conclusions. But it is also clear that if the drug can be

thus confined to one side of the canal by position, it can be excluded from the cranial cavity by keeping the head and neck to or above the level of the lumbar prominence as the patient lies on the back. Moreover, if the drug can thus be applied to a particular region, we ought to be able to do all we want with smaller doses. And our series of cases demonstrated with certainty that we can do so. We have found that with 5 cg. of stovaine or tropacocaine we can, if desired, with the patient on his side, produce an anaesthesia up to the second or third dorsal roots, though this is rarely necessary. Others claim that to do this it is necessary to use 8 cg. of stovaine. This I should strongly deprecate. I have done the most severe abdominal operations with only 5 cg., and only used 6 cg. in a few cases. If the position is carefully studied with a view to making most of the curves of the spine, 5 cg. will carry the analgesia, if need be, to the top of the sternum. It may be that the duration of the analgesia is somewhat longer with 6 cg. than with 5 cg., but the latter figure has been adequate in the last cases of this series.

It is plain, then, that almost every one of Dönlitz's postulates given above is traversed by our experiences with an injection compound much heavier than the cerebro-spinal fluid.

1. We have obtained the *highest* analgesias with the patient lying quietly on the side *before* and after injection.
2. We have found the *lowest* analgesias after puncture in the sitting position with subsequent change to the lying.
3. We have not found it necessary to elevate into the Trendelenburg position with the head low at all, and believe it unnecessary if not actually dangerous. Further, this position becomes unnecessary for the convenience of operating, as the abdominal walls are so relaxed that manipulation within the peritoneum becomes easy.
4. We have found the best results as to high analgesias

Fig. 2.—Glass tubes accurately bent to curves of spine, and filled with solution of sodium chloride of the same specific gravity (1.0070) as that of the cerebro-spinal fluid. A, Sitting position. Tube curved to the line of the dural sac from occiput to caudal termination (frozen section, Braune). This has been injected with 1 c.cm. of our heavy analgesic compound (specific gravity 1.0230) of the same temperature as the solution in the tube. The injection was previously coloured with 1 per cent. methyl violet. In the photograph taken two to three minutes later it is seen to have run down to the sacral sac and to remain unmixed there. In the living subject subsequently laid on the back it would again flow a very little with the cerebro-spinal fluid towards the head. B, The same, quite horizontal. Shows the injection pooled in the dorsal curve two minutes after introduction in the second lumbar space. A little has run down into the sacral sac. Of course the patient can never be injected actually on the back for practical reasons. C, Tube bent to a tracing of the lateral curve with head and pelvis raised before injection, as in Fig. 3. The injection is seen collected in a pool about the sixth and seventh dorsal vertebrae two minutes after introduction through the second lumbar interspace. This curve is greater than usual, but represents what increase may be produced in it by inclining the back a little towards the operator when the patient lies on the side as in Fig. 3. (From a photograph by Dr. E. Worral.)

and absence of after-effects where the level of the body has *not been altered after* injection, and consequently the cerebro spinal fluid has been kept in a state of rest.

The only exception to this last conclusion is found in those rare cases of which we have seen a few examples where, particularly among the labouring classes in advanced life, the spinal column is almost rigid and its curves little or not at all altered by position. Here it may be quite exceptionally necessary to elevate the pelvis more or less *after* injection if high analgesia is required. Such abnormalities must be kept in mind.

As to the volume of the injected compound, it has always in these cases been about 1 c.cm., and has never been increased by withdrawing the piston after the syringe was attached to the hollow needle, and so sucking up the cerebro-spinal fluid to mix with the drug before injection. This, too, is contrary to the practice abroad.

TECHNIQUE.

The details of injection have been precisely as in the first paper (q.v.). But the needles there figured have been altered in a way which has greatly affected the comfort of sterilization. The older needles, stylets, and small cannulae were made of steel nickled over. These very soon blackened from constant boiling and lost their polish, while if put by with the slightest damp they corroded and occasionally choked. Last Easter I suggested to the manufacturers to make them all in hard nickel, a suggestion which they eagerly adopted. After some delay, owing to the difficulty in obtaining the necessary seamless tubing drawn out of hard nickel, they sent me a complete set beautifully finished. These have now been in use for some months, and have proved in every way equal to the steel instruments for the purpose in view, and far more convenient, in that they can be boiled any number of times without change. They should always be as sharp as possible. A blunt needle may push the dural sac before it without entering it, and so lead to failure. Even a fairly sharp needle may fail to penetrate if the sac is *slack*. It may push the posterior wall into contact with the anterior, and even penetrate both. This is best avoided by telling the patient to hold his breath and force at the moment of actual puncture of the sac. Such straining, as is well known, renders the dura tense by forcing the cerebro-spinal fluid downwards.

Except for perineal operations, where the sitting posi-

tion (Fig. 1) was adopted in all, the punctures were made with the patient lying on the affected side with the knees drawn well up on the abdomen, so as to round the back (Fig. 3). The only elevation of the pelvis at all necessary was produced *before the puncture*, in almost all our more recent cases, by laying a fourfold blanket across the table under the trochanteric region, or a 1-inch board, as in Fig. 3, covered with flannel. This slightly increases the lateral curve of the spine, and hastens the gravitation of the injection compound towards the dorsal region.

Fig. 3.—Photograph of patient in typical position on side, with head and neck raised and a 1-in. padded board under the trochanter and iliac crest. The line of the iliac crests is given crossing the fourth lumbar spine. The level of the first cervical spine is seen to be well above that at which the injection compound "pools," and will be relatively higher when patient rolls on the back as in Fig. 4. (From a photograph by Dr. E. Worrall.)

depression. In the lateral position of the spinal column the dorsal curve can be increased by inclining the transverse axis of the body a little towards the operator (Fig. 3), which is best done by an assistant, just before puncture, raising the uppermost knee from the table and pushing the uppermost shoulder back a little. This, of course, means that the direction of the needle during puncture should not be quite horizontal but inclined a little upwards, that is, at right angles exactly to the transverse axis of the body. To reach the dural sac precisely in the middle line

without fail requires a little experience and skill. It is best done by placing the fingers of the left hand at either side of the spinous process above which the puncture is made and so defining the middle line exactly. There have been no failures in this respect in our last 132 cases. There can be no doubt from what we have seen that the injection compound travels along the dural sac *faster* while the patient lies on the side than

Fig. 4.—Photograph of the same patient gently rolled over on the back with the same relations of head, neck, and pelvis. The line across the fourth lumbar spine is seen, and also that the dorsal curve is deeper than the previous lateral curve. (From a photograph by Dr. E. Worrall.)

when on the back. In from one to two minutes there is evidence that the analgesia has reached to its highest point.

All change of posture should be avoided after the injection, except the gentle turn over on the back; and when the patient is being removed from the operating table to his bed the lifting should be done so as not to alter the level of the spine. In bed he should lie with the head and shoulders well raised, and avoid all change of posture. These measures have appeared to all who

have seen these cases to have minimized the chances of sickness or headache, and these sequelae when present have been very trifling as a rule.

Usually from 5 to 10 c.cm. cerebro-spinal fluid were withdrawn before injection. The amount may have influenced the sequelae to some extent, but it is difficult to be certain.

The drug employed in this series of 100 cases was stovaine, as in the last. It was carefully prepared for me, as before, by M. Billon, in glass ampoules, of the strength of 5 per cent. stovaine, 5 per cent. glucose in water 80 per cent. The specific gravity of this solution is 1.0230 at 15° C. as against 1.0070 of the cerebro-spinal fluid, and it is therefore very much heavier than the latter.* The average amount usually injected was 5 cg. of stovaine, or 1 c.cm. of the solution. No adrenal derivative of any kind was used. It is impossible to avoid the suspicion, though it is at present incapable of proof, that some of the ill effects reported here and there abroad after spinal analgesia were due to the adrenal principle employed and not to the anaesthetic drug at all (see first paper).

CLINICAL.

The same plan of analysis by specially prepared tables has been followed out in this series as in the last. The various facts concerning the injection and the immediate and later effects were recorded in columns by gentlemen who specially undertook this work after I had myself done the injection, and was engaged afterwards in preparing for, and in the operation itself. These gentlemen also helped in the adjusting of and maintaining the patient's position for injection on the principles given above, which have been proved to be most important. Up to Case 103, the willing services of Mr. Hugh M. Davies had been given to this supervision throughout. His duties then took him to another hospital, and there was some difficulty in securing regular skilled assistants for the next 30 cases, though all who helped did so most cordially. At this point Captain J. H. Houghton, R.A.M.C., who had been attending my demonstrations from the first, and had seen nearly all the previous series and thoroughly grasped the principles explained to him, volunteered to help regularly, and to carry on the table of observations as before. From this time on there were only two inadequate analgesias. One was a private case of gastro-enterostomy on a patient who had begged for spinal analgesia. Here the analgesia was not quite high enough for the operation, owing to an inconvenient operating table. The loss of sensation was otherwise perfect up to the umbilicus. The other was a case of haemorrhoids. The only other inadequate analgesias—four in number—occurred among the first 20 cases after I had lost Mr. Davies's help. This is only noticed to emphasize the fact that the placing of the patient for injection and the maintenance of the proper position afterwards is most important, and that no one with an imperfect knowledge of the principles on which the procedure is based, however willing and well equipped in other respects, will secure the same uniformity of results as one who has familiarized himself with them by observation and practice. As a matter of fact, in the last 80 cases with instructed co-operation there has only been one real failure to produce analgesia. Again, in the first 50 cases my puncture failed to reach the sac twice, in the second 50 once (68th case); in the next 132 cases the sac was reached *in all*, and more easily, so that practice in puncturing tells very obviously. These considerations may ultimately result in the procedure, should it prove really useful and safe, as I believe it to be, drifting into the hands of the professional anaesthetists in large towns just as general anaesthetics have in this country. But this can only come about when they have devoted as much attention to the study of spinal analgesia in all its aspects as they have done during the last sixty years to chloroform, ether, etc. Still, the surgeon can quite well carry out the whole procedure single-handed, though in some cases he would be glad to have the time free for other matters connected with preparation for operation. At present, however, we all desire to know from actual personal observation as much as possible about the phenomena of sensation, and we devote some time to it. Later on, when these are fairly well understood, once an

adequate analgesia for our operation is produced, it will be unnecessary, and even undesirable, to direct the patient's attention to his feelings at all.

Summary of Tables.

	Series 1.	Series 2	Series 3.	Series 4.	Total.
Strangulated herniae	4	0	1	2	7
R. cure herniae ing. fem vent....	10	7	16	11	44
Acute appendicitis	2	5	3	3	13
Appendectomy <i>d froid</i>	5	3	2	3	13
Gastro-enterostomy	0	0	2	1	3
Other laparotomies	4	5	2	2	13
Kidney operations	0	0	0	1	1
Excis. rectum (Kraske)	0	0	1	0	1
Total abdominal	25	10	27	23	85
Piles (Whitehead) and fistula ...	7	10	6	9	32
Pubis and genitals	7	6	1	2	16
Dislocation of hip reduction ...	0	0	0	1	1
Amputation of thigh, leg, foot ...	1	0	1	1	3
Internal S. cart. and knee	2	2	5	5	14
Wiring fractured patella	0	3	2	2	7
Other operations on lower limb ...	6	8	8	7	29
Failed to puncture dural sac	2	1	0	0	3
	25	30	23	27	105
Total abdominal	25	23	27	23	98
	50	50	50	50	200
Genl. anaesthetic required	14	0	6	0	20

In only one case where the operation was begun under spinal analgesia was it necessary to give a few drops of chloroform for its completion. A man had nearly bled to death from gastric ulcer and was so very exhausted that the physician in charge asked me to employ this method in preference to general anaesthesia for the proposed gastro-enterostomy. He was perfectly comfortable during the operation but began to feel the suturing of the abdominal wound some fifty minutes from its commencement. A few drops of chloroform were given, and the stitching was finished in a few minutes. This patient recovered perfectly and had no vomiting and only a mere trace of headache. Taking the gross failures to effect adequate analgesia by this procedure, a marked improvement is noticed in the last 100 as contrasted with the first. In the first 100 there were 14 failures from all causes, in the last only 6. One of these merely came short in not reaching high enough. In the last 80 cases there have been no misses of any kind. As to dangerous or fatal sequelae of the injection, there have been none in either series. All the 100 cases of the last have left their bed for home well, except one. This patient, a woman, was admitted into hospital for intestinal obstruction of about one week's standing. She had had foul vomiting for days, and bronchopneumonia. The analgesia was good, and passed off soon after the operation. The latter consisted in opening the abdomen and dividing a tight band of fibrous tissue strangulating two coils of intestine. She recovered from the immediate effects of the operation, but failed the next morning, and died during the day. At the necropsy Dr. Thiele, the hospital pathologist, found extensive ulceration of the mucous membrane at the seat of strangulation, and the bowel much diseased for 2 ft. above it. There was extensive and very intense bronchopneumonia of several days' standing, and large infarcts from pulmonary embolism. Heart and kidneys were normal to the eye.

The number of abdominal operations among this second hundred cases was 50, in only 2 of which, including one gastro-enterostomy, was the loss of sensation not quite high enough for the operation. Among them there were no cases

* For the specific gravity of the various solutions which have been used on the Continent, see first paper of March 23rd, 1907.

of post-operative lung disease, though many of them were old and others very obese. In 3 the operation was done on pregnant women with no ill effect. One of these was in the seventh month and had a very bad attack of suppurative appendicitis. Her condition during the necessary operation, which was severe, was remarkable for its particular excellence, and her recovery was uninterrupted after the symptoms of peritonitis present at the time had subsided. She is now approaching her confinement and looking remarkably well.

In the above summary of our first 200 cases it will be seen that there were 95 abdominal operations; 25 of these belong to our first 50 cases, with 9 failures to produce adequate analgesia; 20 belong to the second, 50, with no failures; 27 to the third 50, with 1 failure; and 23 to the fourth 50, with 1 failure. In other words, in the last 70 abdominal sections there have been 2 failures to produce adequate analgesia. But looked at in another way there was only 1 complete failure in 70 abdominal cases, as one of the two mentioned, the gastro-enterostomy, had lost sensation absolutely up to the umbilicus and only wanted 3 in. more to have met the needs of the operation. Such a fault would hardly occur now. In any case this is a very marked improvement on our first series, where experience was lacking, especially as much higher operations were undertaken of late than were attempted in the first series.

In reference to the headaches mentioned above, it is impossible, owing to the unavoidable irregularity in keeping the tables during the first part of our third fifty, to state their exact frequency in figures. It may be said, however, that they were often present during the night following the operation, but rarely the next or following days. It is proverbially difficult to estimate the degree of subjective phenomena, but so much may be stated, that they never appear to have reached the extreme severity which has been reported by some. If present at all they were usually slight, and often would not have been mentioned if not carefully inquired after. Slight sickness was often seen, but in only two or three cases to any disagreeable extent. In spite of these undoubted blemishes on the procedure, so far noted pretty often, patients who have had general anaesthesia as well as spinal unhesitatingly gave preference to the latter. I cannot but think from what has been seen that they are avoidable, and will in the future be fewer and of even less moment than they are now.

The faintness, nausea, or actual sickness sometimes seen at the commencement of the anaesthesia may possibly be explained by the rapid loss of contractile power in the abdominal muscles as the drug takes effect. The result of this would be to allow more blood than usual to accumulate in the visceral veins and to cause more or less sudden anaemia of the brain. If this be so, pressure on the abdomen with the hands or perhaps gentle compression of the veins of the neck might relieve the condition at once. This I intend to try if the opportunity arises. As a rule, however, such faintness and sickness is rapidly over without any treatment.

Since the above was written some months ago, and while waiting to round off this series with 100 cases, my attention has been drawn to a paper² by Professor Krönig of Freiburg (dated October, 1907). In this he claims to have introduced a new principle into lumbar analgesia by making use of *gravity* acting on a heavy injection compound. He bases his conclusions on some experiments very much like my own of a year earlier, though perhaps not so conclusive.³ As he makes no reference to this new method of procedure in the last edition of his own work on Gynaecology, where he gives full details of the method of lumbar puncture employed by him, and as the date of this edition is September, 1906, it is fair to assume that his experiments and experience are recent. They would consequently be more than a year later than my own experiments and demonstrations at University College Hospital. No allusion is, however, made to my paper (dated March, 1907) cited above, which is the more remarkable as it was reviewed in the *Centralblatt f. Chirurgie*, July 20th, 1907, and was in the "reprint" form in the hands of numerous colleagues of Professor Krönig in April last, besides being translated verbatim into one of the French scientific journals. Attention is pointedly called to this oversight in the *Centralblatt f. Chirurgie* in its first issue for this

year (1908). Professor Krönig's paper is, however, welcome now as confirming my own work of a year and a half earlier in every respect and as laying renewed stress upon principles then established by study and proved in practical experience in operating. These principles give, as he too points out, a more certain and safer basis for carrying out lumbar analgesia than those in vogue hitherto. The deduction seems to follow naturally that the choice between stovaine, alpin, novocain and tropacocaine has less to say to success and safety than the mode in which they are employed. Nevertheless I propose in the next series to make use of tropacocaine solutions of the same strength with the same amount of glucose and under as nearly as possible the same conditions with a view to contrasting the results with those obtained with stovaine.

It is impossible to say at present what position lumbar anaesthesia will take in surgery some years hence. One thing, however, is certain—that is, that it claims a very close study, and that those who employ it casually without this incur a grave responsibility. It is not a mere question of injecting a drug at a given point and awaiting a general effect. Many factors have to be considered in the production of a satisfactory condition for operation and blameless recovery, and it is to be hoped that these will be earnestly analysed by competent observers before the procedure is either fully accepted or abandoned.

Major Spencer and Captain Houghton, who had become familiar with the procedure from constant attendance on the demonstrations of it at University College Hospital referred to, have recently introduced it into the Queen Alexandra Military Hospital at Millbank, and have had excellent results in over 50 cases.⁴

REFERENCES.

¹ Die Höhenausdehnung der Spinal Analgesie, *Münch. med. Woch.*, November 27th, 1906. ² *Ibid.*, October 1st, 1907. ³ BRITISH MEDICAL JOURNAL, March 23rd, 1907. ⁴ *Journal of Royal Army Medical Corps*, November 19th, 1907, p. 476.

NOTE BY DR. HENRY HEAD, F.R.S.

Through the kindness of Mr. Barker I have been enabled to study the form and distribution assumed by the loss of sensation which follows the injection of stovaine into the spinal canal. I need scarcely say that the conditions which precede and follow a surgical operation are unfavourable for any complete examination of sensation. It is therefore impossible to make a complete statement as to the nature of this anaesthesia at present.

But certain points emerge even at the present stage. Sensibility to touch and pressure disappear later, and in incomplete cases are less widely lost than sensibility to pain, heat, and cold. The part becomes insensitive to cotton-wool before pressure ceases to be appreciated. With the loss of sensation to pressure the patient loses the power of recognizing the position into which his limbs are placed passively. This is one of the last forms of sensation to be abolished. As far as I have been able to see at present, the pain of pressure is not abolished unless the tactile sensations of pressure are diminished or lost.

One of the most interesting facts brought out by the cases of unilateral anaesthesia is the complete abolition of sensation and motion in one leg without interference with the motor or sensory function of the opposite limb. From this it is obvious that the afferent mechanism attacked by the drug is concerned with the sensory impulses before they have crossed the spinal cord. Stovaine does not attack the long afferent columns, at any rate at first. It probably acts on the motor and sensory fibres in the spinal canal or just after they have entered the spinal cord.

The upper level of the loss of sensation seems to resemble that found in affections of the roots rather than that produced by lesions of the spinal cord. The borders correspond roughly to root segments and cutaneous sensibility to pain, to heat, and to cold is usually lost to a higher level than the sensations produced by touch and by pressure.

AN INTERNATIONAL UNIVERSITY.—The King of the Belgians is said to have some idea of founding an international university at Tervueren, in Belgium, to which students of all nations would be admitted, and where scientific men of world-wide celebrity would be invited to lecture. An amalgamation of the international scientific societies and museums in Belgium might, it is thought, form the nucleus of an international university.