An Address

ON

SOME PROBLEMS CONNECTED WITH BENIGN ENLARGEMENT OF THE PROSTATE.*

BY

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THERE are many problems connected with benign enlargement of the prostate which provide material for serious thought and discussion. Some of these problems have not yet been solved satisfactorily, and others are treated in different ways by many of the workers in this field of surgery.

Some writers still employ the term "hypertrophy," but this is incorrect, for hypertrophy of an organ implies an increase in size of all its component parts, whereas in the pathological prostate the enlargement is essentially glandular. It is now generally agreed that the condition, which for want of a better name is usually called "enlargement of the prostate," is due to an adenomatous formation, but the actual origin of the adenomata is as yet unsettled.

Before discussing the theories which have been advanced to account for these pathological changes, a brief reference to the anatomy and histology of the normal prostate is essential.

The gland is traversed by three canals, the urethra and the two common ejaculatory ducts, by which it is arbitrarily divided into five lobes, an anterior lobe in front of the urethra, two lateral lobes surrounding the urethra above the ejaculatory ducts, a posterior lobe below the ejaculatory ducts, and a so-called middle lobe between the upper part of the two lateral lobes. This arrangement is useful for descriptive purposes, but has no real anatomical basis, for the tissues composing the lobes are continuous with each other and quite inseparable.

The stroma of the prostate is formed of a felt-like mass of unstriated muscle, fibrous, and elastic tissue containing plicated tubular glands in its meshes. The portion immediately in front of the urethra, called the anterior commissure, is usually devoid of glandular elements, thus accounting for the absence of adenomatous tissue in this situation in the ordinary type of prostatic enlargement. When glandular tissue is present it may undergo pathological changes together with the rest of the gland, giving rise to annular enlargement, or rarely the change may be confined solely to it.

Beneath the mucous membrane of the trigone and the posterior urethra are four groups of glands which are quite separate and distinct from those of the prostate. Collectively they are called the submucous or accessory prostatic glands. One group lies beneath the trigone; a second around the internal meatus; the third and most important, distinctively named the periurethral or sub-cervical glands of Albarran, is situated in the submucous tissue of the prostatic urethra. This group consists of thirty or more branched tubules which open into the floor of the urethra between the neck of the bladder and the verumontanum. The fourth group is in the anterior wall of the urethra.

Of the many theories which have been suggested to explain this disease two only are worthy of consideration—the degenerative and the neoplastic.

The degenerative theory is based on the resemblance of the changes in the prostate to those in the female breast at the menopause. The microscopical appearance of the enlarged prostate is so similar to that of chronic lobular mastitis that frequently prostatic can only be distinguished from mammary tissue by its characteristic corpora amylacea. The similarity is so great that Henry Wade considers the disease should be called "chronic lobular prostatitis"; he attributes the change to alteration in a normal internal secretion associated with normal diminution of sexual activity.

The neoplastic theory is the one now more generally held, but even if this be the correct explanation the underlying cause of the adenomatous formation may still be due to a degenerative process.

There are two views regarding the origin of the adenomata; one is that they are true tumours of the prostate gland itself, and that their capsule is formed by the compressed but unaffected remains of the gland, analagous to an adenoma of the thyroid. The other view, held by many Continental writers, is that the adenomata arise in the periurethral glands, and that the prostate takes no part in their formation, but undergoes atrophy and compression as the tumours enlarge. The latter theory can account for the well-known freedom from adenomatous formation of the prostatic tissue below the ejaculatory ducts, since the periurethral glands do not extend below the verumontanum.

In this connexion it is an interesting fact that, owing to the escape of the posterior lobe, the verumontanum is seldom seen in the tumour removed by the suprapubic operation; its presence in an operation specimen would signify involvement of the prostatic tissue below the ejaculatory ducts, and consequent destruction of these ducts by its removal. Tumour formation in the accessory glands can also account for the pedunculated adenoma, the so-called middle lobe, overhanging the internal meatus, and also for the occasional small adenoma in the posterior wall of the prostatic urethra just below the internal meatus, which is sometimes, though rarely, the sole cause of obstruction.

Some writers, notably Motz and Pérearnau,¹ Papin and Verliac,² and Lendorf,³ consider that the adenomatous change is limited solely to the periurethral glands, and that the prostate takes no part in its formation but is compressed and atrophied by the new growth. It is difficult to reconcile such a view with the naked-eye appearance of many enlarged prostates in the early stage which show adenomatous masses scattered irregularly throughout the lateral lobes at a considerable distance from the anatomical position of the periurethral glands.

And, again, the theory of a periurethral origin is untenable in the rare cases in which, after removal of an enlarged prostate, a second re-forms, identical with its predecessor in every respect, and as easily enucleable. Since all the periurethral glands must have been removed at the first operation the second growth can only have arisen from prostatic tissue surrounding the original adenomata.

In all probability both views are more or less correct, since in many cases the adenomatous change involves both the prostatic and the periurethral glands, but the practical application of these views is of importance to both patient and operator. If the adenomata are considered to be of prostatic origin then, after enucleation, all remaining portions of the prostate should be removed to prevent recurrence; but if, on the other hand, the change is thought to be limited solely to the periurethral glands, there is no necessity to remove any portions of prostatic tissue remaining in the wall of the cavity, and consequently the patient is saved the shock of a prolonged operation.

When the etiology of the disease is settled the correct surgical procedure will follow naturally, but until then it seems best to be content with the Freyer operation if, after digital enucleation of the tumour, the walls of the prostatic cavity are quite smooth; but if the walls are uneven, and contain irregular masses of small adenomata, an open operation should be performed and as much of the prostatic tissue removed as possible.

Since it is now universally agreed that, whenever possible, "prostatectomy" is the best treatment for benign enlargement of the prostate causing symptoms, the problems connected with it fall naturally into three groups: pre-operative, operative, and post-operative. It will only be possible to discuss some of these, but before doing so I will consider the cases which are clearly unsuitable for prostatectomy.

INOPERABLE CASES.

In general they belong to the class that constitutes bad surgical risks, no matter what the operation, and are those with advanced senile changes, gross arterio-sclerosis, pronounced chronic nephritis, organic disease of the heart or nervous system, diabetes, and obesity. Some of these

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conditions, such as glycosuria and obesity, can be improved so greatly by appropriate treatment that they cease to be serious operative risks, but on the whole the "prostatic" with these added complications is better treated by other means. Of these diathermy and deep x-ray therapy are at present under trial, but the results are uncertain.

Diathermy is applied by means of a special metal electrode, containing a thermometer, which is passed into the rectum and pressed against the prostate. The current is started, and slowly increased until the initial sensation of heat becomes one of discomfort; it is then reduced until the discomfort subsides, and is kept at this strength for twenty minutes. At this stage the temperature of the electrode will be about 111° F., but the temperature of the prostate will probably not be above 107° F. The treatment is repeated every few days, with gradually increasing intervals.

Deep x-ray therapy has been tried frequently, with results sometimes brilliant but more often disappointing; still, these methods are well worth a trial before the patient is condemned to a catheter life. If for any reason diathermy or deep x rays cannot be employed, or if they have been tried and failed, the only two possible procedures are permanent suprapubic drainage or the regular use of a catheter.

Catheterization is indicated when the patient is either very old or is obviously going downhill; when he is sufficiently intelligent to keep and use the catheter aseptically, or sufficiently well off to have it done for him; when permanent suprapubic drainage is advised and refused; and when nocturnal frequency is due to a large amount of residual urine. Apart from severe cystitis, nocturnal frequency is the complication which troubles the patient most, for his nights are so disturbed that he gradually becomes worn out from loss of sleep. Contrary to expectation it is not always dependent upon the quantity of residual urine, for some patients with a healthy bladder and a 6 oz. residuum may only be disturbed twice in the night, while others with only 2 oz. may have to urinate as often as six times. When nocturnal frequency is associated with less than 4 oz. of residual urine it is due either to cystitis, to highly acid urine, or to irritability of the bladder, and can be relieved by appropriate remedies; but when it is due to 6 or more ounces it can be greatly diminished by catheterization at bedtime, provided the patient abstains from drinking after 8 p.m.

Permanent suprapubic drainage is required when catheterization cannot be tolerated, or when it is difficult or impossible owing to the size and shape of the prostate; when it either causes haemorrhage or there are repeated severe haemorrhages unconnected with catheterization; when the patient suffers from relapsing subacute cystitis or from toxæmia due to chronic cystitis; and when nocturnal frequency is not relieved by catheterization. It is impossible to lay down any hard-and-fast rule, for each case must be judged on its merits and on the home conditions of the patient, but, speaking generally, in cases that are clearly inoperable catheterization should be given a trial whenever possible, for on the whole it causes less mental disturbance and less physical disability than the suprapubic tube. The cystitis that is the inevitable sequel of regular catheterization, no matter how carefully it is carried out, seems to cause very little discomfort; if it becomes troublesome permanent suprapubic drainage must be established.

The catheter should be passed about four times in the twenty-four hours when retention is complete; in the morning and at night when the amount of residual urine is about 10 oz.; and at bedtime only when the residual urine does not exceed 6 oz.

PRE-OPERATIVE PROBLEMS.

Age.

Enlargement of the prostate generally commences between the ages of 50 and 60, but the patient takes little notice of the early symptoms, regarding them as a necessary accompaniment of advancing years, and usually only seeks advice after the age of 60. By then the signs and symptoms are quite definite and an operation is clearly

indicated. But if the case is seen when both enlargement and symptoms are slight, the question arises whether an immediate prostatectomy should be advised.

Provided the residual urine is not above 1½ oz., an operation at this stage is, in my opinion, unnecessary, for two reasons: first, in a certain proportion of cases the condition remains stationary for many years; and secondly, the operation may be very difficult, for in the early stages the line of cleavage between the adenomatous tissue and its prostatic capsule may be so ill defined that digital enucleation is impossible. The surgeon is then obliged to dissect away the affected tissues with scissors and forceps, an operation which requires considerable skill and experience. Therefore if a patient is seen in the early stage he should be watched carefully, and examined every six months for residual urine and renal efficiency, and operated on as soon as these indicate the onset of prostatic obstruction. In these early cases residual urine is the best sign of obstruction, and my rule is to operate when it amounts to more than 1½ oz.

Advanced age is no great bar to operation, provided the patient is otherwise healthy; the octogenarian often gives less anxiety than the man of 60, for he has only attained his years by the help of a sound constitution, and therefore his condition and resistance are relatively equal to those of the younger man. In my experience the most dangerous age is between 65 and 75, for by then obstructive symptoms have been present for some years, and the patient's kidneys have been so damaged by back pressure, and possibly by sepsis as well, that an operation may easily prove fatal.

It therefore follows that the optimum age for the operation depends entirely on the symptoms and not on the size of the gland. The approximately young man, with symptoms of prostatic obstruction without pronounced enlargement of the gland, is in as great need of surgical activity as the old man, with a large prostate causing practically no symptoms, is in need of masterly inactivity.

The Condition of the Patient.

Recovery after prostatectomy depends mainly on two factors—the renal function and the resistance to sepsis. Therefore before an operation is performed the renal function must be estimated very carefully both clinically and chemically. The clinical signs of a defective renal function are of the greatest importance and are often more valuable than chemical tests. The chief clinical signs of a defective renal function are a dry tongue, increased thirst, a sallow complexion, a poor appetite, and a distaste for meat. If, in addition, there is polyuria or oliguria the picture is complete.

The most reliable chemical tests are (1) the blood urea, and (2) the urea concentration test. In cases of enlarged prostate the blood urea test is the best, for the urea concentration test is apt to give a false impression by being on the low side if there is much residual urine. This can be overcome by collecting the urine with an indwelling catheter during the test, but the catheter may act as an irritant and so influence adversely the action of the kidneys.

In a healthy man on an ordinary diet the blood urea should range between 25 and 50 mg. per 100 c.cm. of blood according to age, and the urea concentration in the urine after a dose of 15 grams of urea in 100 c.cm. of water given on an empty stomach should rise from 2 per cent. in the second hour to 3 per cent. or over in the third hour. The value of the urea concentration test lies not so much in the actual quantity of urea excreted by the kidney as in the ability of the kidney to increase the concentration in each hour, and so give an indication of its capacity under a strain. Thus kidneys that yield, say, 1.9 per cent. in each of the three hours are not so efficient as kidneys that excrete 1.7 per cent., 1.8 per cent., and 1.9 per cent. in consecutive hours. In such a complicated structure as the human body chemical tests and clinical signs are often deceptive, but when both are taken in conjunction they give the most reliable indication that we have at present of the functional capacity of the kidneys.

Is it possible to fix a minimum limit to the urea concentration and a maximum limit to the blood urea beyond

either of which prostatectomy would endanger the life of the patient? In a previous communication⁴ on this subject I gave the following answers, to which I still adhere.

"In my opinion the limits are a urea concentration of not less than 1.7 in the third hour, and not more than 50 mg. of urea in 100 c.cm. of blood, always provided that the clinical condition is satisfactory. When the clinical signs of a defective renal function are definite no chemical test should influence the surgeon in favour of an operation; and, conversely, if the clinical condition is a good one and the chemical tests are not too far below standard, he need not hesitate to operate."

In employing these tests as indications for or against prostatectomy the condition of the patient at the time they are made must be taken into consideration. When complete retention supervenes on long-standing obstruction the renal function will be greatly depressed, and, therefore, the tests will not indicate the real capacity of the kidney; but if they are made some days after the retention has been relieved and the general condition of the patient has improved they will be comparatively reliable.

The following two examples point to the importance of taking both clinical and chemical evidence into consideration.

1. A man, aged 65, with marked clinical and chemical signs of a defective renal function from long-standing prostatic obstruction, underwent suprapubic drainage for acute retention. Three months later the clinical picture was that of a man in moderate health but with a sallow complexion. The blood urea was 79 mg. per 100 c.cm. and the urea concentration did not rise above 1.5 per cent. in the third hour. At the end of another three months the results of the chemical tests were unchanged. Operation was therefore contraindicated. Six months later, after a brief illness, he died of uraemia.

2. A thin man, aged 56, looking very ill, had pyelocystitis, thick foul urine, and complete prostatic obstruction of six months' duration, necessitating regular catheterization. The blood urea was 40 mg. The urea concentration was 1.4 per cent., 1.65 per cent., and 1.6 per cent. in the three hours. Suprapubic drainage was performed and there was improvement with bladder lavage and vaccine treatment. Two months later the tongue was moist and clean, there was no thirst, a good healthy appetite was present, and the patient had gained 1 st. in weight. The blood urea was 46 mg. and the urea concentration 0.55 per cent., 1.25 per cent., and 1.5 per cent. in the three hours. The concentration was very low, but a steady rise indicated a kidney capable of withstanding a strain. The blood urea was normal for the age, and the clinical signs were excellent. Prostatectomy was followed by uneventful recovery and departure from hospital in six weeks. Three years later the patient was alive and well.

The first case was only a fair risk clinically and a bad one chemically, while the second was a good risk clinically and a poor one chemically. Experience has shown that life will be seriously endangered by prostatectomy if the blood urea is much over 50 mg. per 100 c.cm. of blood and the urea concentration below 1.5 per cent. in the second or third hour.

Since clinicians and biochemists have co-operated in gauging the renal function, deaths from uraemia after prostatectomy seldom occur, and, excluding pulmonary embolism, which is an ever-present danger, the greatest post-operative danger nowadays is sepsis in the form of suppurative pyelonephritis. MacAdam and Shiskin⁵ have pointed out that the cholesterol content of the blood gives a fair indication of the power of resistance to sepsis, and that patients with a high blood urea and a normal blood cholesterol all recovered from prostatectomy, whereas nearly all those with a high blood urea and a low blood cholesterol died. The normal cholesterol content ranges between 0.13 per cent. and 0.19 per cent.; when it is below 0.13 the resistance to sepsis may be considered so low as to constitute a bad operative risk.

When there is no immediate urgency the dangers of post-operative sepsis can be diminished very greatly by a course of preliminary treatment. The mouth and teeth should be inspected and treated by a dentist if necessary. Moderate infection of the bladder should be treated by diuresis, urinary antiseptics, and lavage. In many cases three or four doses of an autogenous vaccine at intervals of five days will increase the patient's resistance to sepsis. When cystitis is severe the bladder must be drained suprapubically and irrigated continuously in addition to the measures already advocated.

For *B. coli* infections the best antiseptic is hexamine, but as it only acts in an acid medium the urine must be kept strongly acid with ammonium benzoate or acid-sodium phosphate; for coccal infections hexyl-resorcinol (caprokol) is

better than hexamine. It is interesting to note that patients with mild cystitis are less liable to post-operative sepsis than those with a healthy bladder, for their immunity has been raised by the infection.

Many prostatic patients suffer from flatulent dyspepsia and intestinal distension, which occasionally become acute after operation. These gastro-intestinal disturbances may be due to dietetic indiscretions, but more probably, in these cases, they are symptoms of defective kidneys. When due to the latter they will only subside when the back pressure on the kidneys has been relieved by preliminary suprapubic drainage, but if the kidneys are efficient they must be treated before operation by dieting, intestinal antiseptics, and judicious purgation.

OPERATIVE PROBLEMS.

Preliminary vaso-ligation is performed regularly by many Continental surgeons, but in this country it is only employed as a routine measure by a few. It is useful as a certain preventive of post-operative epididymitis, and is definitely indicated in all cases of pre-operative epididymitis. The question of procreation need not be considered, for sterility is usual after prostatectomy. Where impotence is a consideration—and this matter should always be discussed with the patient beforehand—vaso-ligation is contraindicated.

Without discussing the merits and demerits of the suprapubic and perineal routes, it is sufficient to say that for many reasons the suprapubic operation is the one usually employed in this country. To those who operate I would only emphasize the importance of a long incision in the abdominal wall. This allows the hand to be sunk between the recti, and enables the finger in the bladder to reach the prostate with the greatest ease. This free access to the prostate also permits enucleation with a gloved and therefore sterile finger, and dispenses with the necessity for a finger in the rectum.

Pre-operative Drainage.

In many cases, the number of which will probably increase with the experience of the surgeon, preliminary drainage is required for a varying period, either by means of an indwelling catheter or a suprapubic tube. Cabot⁶ has pointed out that in the early stages of prostatic enlargement hypertrophy of the bladder wall is accompanied by congestion of its mucosa, a condition which lowers its resistance and may lead to serious post-operative infection. Preliminary drainage lessens the risk by relieving the congestion. Increasing obstruction, with its accompanying residual urine, leads to so-called back-pressure effects on the kidney, manifested, at the commencement, by dilatation of its pelvis and calyces, congestion of its parenchyma, and depression of its function, and ending in chronic interstitial nephritis, renal deficiency, and retention of urea in the blood.

Relief of back pressure by drainage of the bladder will restore the depressed or tired kidney to normal in a few days, but without this relief the sudden strain thrown upon it by such a severe operation as prostatectomy might inhibit its function altogether. The diseased kidney, provided its function is not too severely impaired, will also respond to the rest afforded by drainage in a remarkable manner, and many a case which at first sight appears hopeless will eventually recover to such an extent that a successful operation can be performed.

The use of the indwelling catheter is practically restricted to cases with slight renal deficiency or chronic urinary retention, for it cannot be employed when the bladder or kidneys are infected or when the prostate is bleeding. By some patients it is tolerated well, but in others it causes discomfort and irritates the urethra and bladder, and through them the rest of the urinary tract, and so does not give such complete rest to the patient or his kidneys as the suprapubic tube. It is difficult to keep the catheter surgically clean, and it always sets up a mild urethritis which must be a source of infection when the prostatectomy is performed. Its only advantage is that it leaves the operation field clear for the subsequent prostatectomy.

In nearly all cases in which primary prostatectomy is contraindicated preliminary suprapubic drainage—in other

words, a two-stage operation—is preferable to an indwelling catheter. The suprapubic tube gives absolute rest to the patient and his urinary tract, does not irritate or infect his bladder, and enables him to move about in bed and sleep in comfort.

Pre-operative drainage is necessary (1) when there is complete retention or more than 4 oz. of residual urine, (2) for renal deficiency, (3) for severe haemorrhage from the prostate, (4) for urinary sepsis and cystitis, and (5) for the patient worn out by nocturnal frequency. It may be necessary for a week only or for several months, during which time the bladder, if infected, is treated by regular lavage, and the patient's immunity raised by an autogenous vaccine.

When the kidneys are defective the duration of drainage depends solely upon the improvement in the clinical condition and the chemical tests. If the deficiency is only due to renal fatigue from back pressure, drainage for a week or ten days will generally suffice, but when it is secondary to organic changes in the kidney drainage may be required for many months. If by nine months the blood urea has not fallen and the urea concentration is still below normal, there is no hope of improvement, and the patient must be content to wear the suprapubic tube for the rest of his life.

We all know that a tired horse will carry a load uphill if given a rest half-way, but if forced he will either jib or drop down dead. The same applies to a kidney tired out by prostatic obstruction: increase the load by a severe operation and it will cease work altogether; but if it be rested by means of suprapubic drainage, prostatectomy will eventually be possible and safe.

There are many surgeons who object to the two-stage operation on the grounds that it necessitates two anaesthetics and two operations, that enucleation is more difficult, and that a subsequent open operation is not possible. The first disadvantage is almost negligible, for the cystostomy can be performed under gas and oxygen with little or no discomfort. Enucleation may be more difficult, but not if the opening in the bladder is made high enough to permit of its enlargement downwards at the second operation. Lastly, an open operation *can* be performed, but requires care in separating the bladder from its adhesion to the abdominal wall.

However optimistic we may be, it is impossible to overlook the many dangers, both local and general, of prostatectomy, and there is no doubt that its gross mortality would be greatly diminished if the two-stage operation were more generally adopted. Only recently I heard of a case of acute retention in which an energetic operator performed an immediate prostatectomy. The patient made an uninterrupted recovery, but it is enthusiasm such as that which helps to make the gross mortality of prostatectomy in the London hospitals round about 20 per cent.—a figure which is far too high.

In conclusion, let me summarize, by three hypothetical cases, the problems I have dealt with.

No. 1.—A man, aged 60, with prostatism, enlargement of the gland, and 2 oz. of clear residual urine. The tongue is moist, the appetite is good, and the complexion is clear. The blood urea is 35 mg. and the urea concentration over 2 per cent. A one-stage prostatectomy can be performed with safety.

No. 2.—A man, aged 68, with pronounced prostatic symptoms and 4 oz. of clear residual urine. The tongue is slightly dry, thirst is increased, and the appetite is not so good as it used to be. The blood urea is 45 to 50 mg. per 100 c.cm., and the urea concentration is 1.9 per cent. This is a clear case of tired kidney requiring rest for a week or ten days before prostatectomy, either by means of an indwelling catheter or a suprapubic tube. My choice would be the latter.

No. 3.—A man, aged 70 or more, with 10 oz. of residual urine, cystitis, and obvious clinical signs of a defective renal function. The blood urea is well over 50 mg. and the urea concentration below 1.7 per cent. A two-stage operation is imperative, with an interval of anything from three weeks to eight months between the first and second stages.

REFERENCES.

- ¹ Motz and Pécarnau: *Ann. des Mal. des Organes Génito-Urinaires*, 1905, lxxx, 1521.
- ² Papin and Verliac: *Arch. Urol. de la Clinique Necker*, ii, Fasc. iv, p. 425.
- ³ Lendorf: *Arch. f. Klin. Chir.*, 1912, xxvii, 467.
- ⁴ Nitch: *Medical World*, vol. xviii, No. 2, 1923.
- ⁵ MacAdam and Shiskin: *Brit. Journ. Surg.*, vol. xii, 47, 1925.
- ⁶ Cabot, quoted by Hume: *Lancet*, 1925, i, p. 953.
- ⁷ Sir Cuthbert Wallace: Bradshaw Lecture, Royal College of Surgeons, 1927.

THE ISOLATION OF *B. PARATYPHOSUS* B FROM SEWAGE.

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IN the past the demonstration of specific pathogenic organisms in sewage and water has proved of the utmost technical difficulty. Methods of selective culture, however, have greatly facilitated the isolation of such bacteria (for example, typhoid-paratyphoid group) from material in which they are greatly outnumbered by other organisms, and these methods have been most successfully applied in the bacteriological examination of faeces from cases of enterica (Browning, Gilmour, and Mackie, 1913; Mackie, 1917; and others). A further development has been the application of selective methods in the examination of sewage and water. Even though the typhoid-paratyphoid bacilli are present in communal sewage containing the excreta of diseased persons or carriers, dilution must render them exceedingly scanty in proportion to other bacteria, and it might be expected that the greatest difficulty would be experienced in demonstrating them even by selective methods. The same would apply to water. The success obtained by Wilson (1928) in demonstrating *B. typhosus* in Belfast sewage by his method of selective culture marks a great advance in this branch of bacteriological investigation. I have applied Wilson's technique along with other methods in the examination of sewage in Edinburgh, and the object of this communication is to record the results of the investigation, which seem of considerable interest and importance from the point of view of public hygiene.

Methods.

The following cultural methods were employed.

1. The "*glucose-bismuth-sulphite-iron-brilliant-green medium*" introduced by Wilson and Blair (1928) and termed by them medium B. The rationale of the use of this medium is explained by Wilson as follows. In the presence of a certain excess of sodium sulphite, bismuth sulphite tends to suppress the growth of most coliform bacilli; when, in addition, a fermentable carbohydrate is present, *B. typhosus* reduces the sulphite to a sulphide, the latter reacting with the iron salt to form iron sulphide, which blackens the colonies. The brilliant green enhances the selective action of the medium for organisms of the enterica group.

With a view to obtaining definite knowledge of the colony appearances of various organisms on this medium, strains of *B. typhosus*, *B. paratyphosus* A, *B. paratyphosus* B, a typical *B. coli*, *B. proteus* and *B. fluorescens* types were plated out. The growths obtained varied very considerably in appearance with the strain of organism and the period of incubation.

B. typhosus produced, after twenty-four hours' incubation, minute clear discrete colonies which after a further twenty-four hours became jet black, or, more commonly, a bright green colour.

B. paratyphosus A was similar to *B. typhosus* except that none of the colonies were black.

B. paratyphosus B. After twenty-four hours' incubation all the laboratory strains of this organism produced clear discrete colonies each 1 mm. in width. After forty-eight hours' incubation these colonies became bright green. In addition, however, one of the strains produced black colonies with a metallic lustre, which after four days' incubation were 6 mm. in diameter and had a raised greyish centre.

B. coli produced, after twenty-four hours, colonies similar to those of *B. typhosus*. After further incubation most of these became bright green; some which grew slowly assumed a black colour, but without metallic lustre.

Some strains of *B. proteus* were inhibited for twenty-four or forty-eight hours, but later produced green colonies varying slightly in shade.

B. fluorescens was also inhibited for twenty-four or forty-eight hours, but later produced dull green colonies, which eventually became brown.

When this medium was inoculated with actual samples of sewage it was found that it inhibited the growth of a very large number of the coliform organisms present. The colony appearances of any one organism, however, varied; thus, "enterica" group may be present in a given sample of sewage and yet may not necessarily produce colonies with a specially distinctive appearance.

Contrary to Wilson's findings, I found that lactose-fermenting organisms might produce black colonies on the B medium. For this reason subinoculation of such black colonies on Wilson's modification of the Endo medium, in which saccharose replaces the lactose, was deemed less suitable than on one in which saccharose was present in addition to the lactose. The presence of the second sugar does not appear to influence any action an organism may have on the other substance. MacConkey's medium containing both sugars was found to give sharper demarcation between pale and pink colonies than the corresponding Endo