before onset, canteen meals, household pets, contact with other similar illness, and presence of schoolchildren in the family. The only factor that stood out clearly was the importance of schools and schoolchildren in Sonne dysentery. Age-specific secondary attack rates and serial intervals between cases in families showed differences in the bacteriological and clinical groups.

In a therapeutic trial of neomycin and phthalylsulphathiazole in 83 patients, all bacteriologically negative, little difference in rate of recovery was found between those treated with either drug and kaolin and those treated with kaolin alone.

We are indebted to Glaxo Laboratories for supplying the preparations used in the therapeutic trial; to Dr. C. E. D. Taylor, of the Virus Diagnostic Laboratory at Colindale,

for the virus isolation tests; to Dr. Z. Bencić for his help in the analysis of the records; to Mr. F. T. M. Downing for technical assistance; and to the South-east Metropolitan Regional Hospital Board for a grant in respect of the bacteriological part of the investigation.

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PROSTATECTOMY MORTALITY

A CHANGING PICTURE

BY

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The mortality of prostatectomy has fallen in recent years. Early in this century a figure of about 20% was published from large hospitals (Groves, 1908; Dobson, 1921; Wade, 1921; Thomson-Walker, 1930). The decline in death rate evidently started about two decades ago, for Rees (1947) gives a figure of 8.4% (463 cases) at Birmingham for the seven-year period from 1939, and Salvaris (1960) records a mortality of 4.2% (1,200 cases) from the urological hospitals in London.

In individual series, however, where careful selection probably occurs, results have always been better, and even at an early period mortality was 5% or less (Tenney and Chase, 1906; Freyer, 1912). One surgeon's choice of patients for operation differs from another's and, indeed, a single surgeon's choice may alter considerably in the course of years. For this reason comparison of published mortality figures for an operation like prostatectomy may be fallacious. By careful selection of cases for operation a very low mortality can undoubtedly be achieved, but this merely raises significant questions. What happens to those who have not been considered for surgery? Do they languish with a permanent suprapubic cystostomy? Do they succumb to infection or renal insufficiency? How many are there of them?

We have taken for study two series of cases of urinary retention due to prostatic enlargement from a single hospital and separated by an interval of eight years. This has two advantages. In the first place some form of treatment was essential for each patient to relieve his retention; the two groups are therefore closely comparable. Secondly, in this investigation we knew exactly how many patients were not chosen for prostatectomy and what happened to them.

The purpose of the investigation was threefold: to obtain full information of the number and type of cases needing treatment for prostatic obstruction, to contrast the causes of death in the two series, and to find out the effects of retention on prostatectomy mortality.

The Survey

Two samples of 200 patients each were chosen, the first from April, 1949, to December, 1952 (series A), and the second from December, 1957, to May, 1960 (series B). Each was a consecutive series of patients with urinary retention due to prostatic enlargement coming under the care of a surgical team who accepted all such cases admitted to hospital.

All men in each group were under the personal care of one of us, and the two periods were chosen because they were the earliest and the latest during which such personal supervision was undertaken and accurate records were kept.

"Mortality" is given a wide reference. It is taken to mean death of the patient from whatever cause while still under hospital care even after treatment of his prostatic obstruction had been successfully concluded. It has no arbitrary time limit.

The types of prostatic obstruction covered by the two series are adenoma, carcinoma, and chronic inflammatory disease, with or without calculus formation. Acute prostatitis is not included. The obstruction was such as to cause urinary retention and to necessitate relief by some form of bladder drainage. By retention is meant a bladder palpably distended on simple abdominal examination; we have not included those who clinically or radiologically merely had a high residual urine after micturition. Cases of transient retention of nervous or postural origin after surgical operations have been eliminated, as have those who after a single catheterization regained normal micturition.

TABLE I.—Causes of Urinary Retention in Series A and Series B

	Fibro-adenoma		Carcinoma		Fibrous/Calculus		Total	
	A	B	A	B	A	B	A	B
Prostatectomy ..	107	109	19	13	3	6	129	128
No operation ..	55	50	10	22	6	—	71	72
Total ..	162	159	29	35	9	6	200	200

Classification according to the nature of the prostatic obstruction is given in Table I. The diagnosis in all cases of prostatectomy was confirmed histologically; those not coming to operation were classified on clinical or post-mortem evidence. It will be seen that on pathological grounds the causes of obstruction are closely similar in the two series.

Initial Treatment of Retention

A patient admitted to hospital or coming under our care from another ward with urinary retention was treated either by preliminary drainage of the bladder or by immediate prostatectomy. As an exception to this, however, no treatment of any kind was given to two patients in series A and three in series B, because they were moribund on admission and died within 36 hours.

For many reasons we did not usually carry out emergency prostatectomies, but there were four in series A and one in series B. In addition, when a patient had a subacute or chronic retention and was otherwise in good health, bladder drainage was sometimes regarded as unnecessary and operation was performed within a few days; this accounted for 14 patients in series A and 11 in series B. After bladder drainage by suprapubic or urethral catheter some patients were fit for early operation, some after a short period of assessment, and others only after a more or less prolonged course of medical treatment. The remainder underwent no operation; either they died without ever becoming fit enough for surgical help or they regained normal micturition and prostatectomy was not considered advisable.

Table II shows the number of patients in each series who came to prostatectomy, with the corresponding

TABLE II.—Mortality from Urinary Retention With and Without Prostatectomy

	Series A		Series B	
	Cases	Deaths	Cases	Deaths
Prostatectomy	129	20 (15.5%)	128	8 (6.2%)
Bladder drainage only ..	71*	45 (63.3%)	72†	46 (63.9%)
Total	200	65 (32.5%)	200	54 (27%)

* Including 2 not fit for any form of treatment.

† Including 3 not fit for any form of treatment.

mortality. The very close similarity in prostatectomy rate in series A and series B will at once be seen—129 cases compared with 128 (about 64% of the total in each series). The operation and non-operation groups are considered separately.

FIG. 1.—Prostatectomy and its mortality (according to age-groups).

Prostatectomy

Fig. 1 indicates the age distribution of the patients coming to prostatectomy. Series A is compared with series B, and the mortality of each group is included (the figures in the two series, 129 and 128, being almost identical, direct comparison may be made). The distribution was approximately the same in the two series, but there was a fall in mortality in the second series and it affected each one of the age-groups, particularly those of 75 years and over.

The types of operation performed in the two series are contrasted in Table III. Probably such differences

TABLE III.—Type of Prostatectomy Performed

	Series A		Series B	
	Number	Deaths	Number	Deaths
Retropubic ..	75	9	94	7
Transvesical ..	43	9	20	—
Transurethral ..	11	2	14	1
Total ..	129	20	128	8

of technique as there were had no influence on mortality.

The fall in mortality—15.5% to 6.2% (Table II)—is statistically significant ($\chi^2=4.68$ and $P=0.03$) and can be attributed to a better management of the patient before, during, and after operation. Details of management are beyond the scope of this paper, but they include closed bladder drainage before and after operation, the use of hypotensive anaesthesia, early rising after operation, avoidance of intravenous infusion, and the exclusion of bladder wash-out in the ward.

FIG. 2.—Duration of pre-operative bladder drainage before prostatectomy. (Also 22 cases in each series with drainage over 21 days.)

Antibiotics, used sparingly in the first series, were virtually abandoned in the second as unnecessary, their sole use being as a prophylactic cover during operation in those suffering from recurring bronchitis. Sulphadimidine ("sulphamezathine") in the first series and sulphafurazole ("gantrisin") in the second were given daily as long as the catheter was draining the bladder.

The average duration of pre-operative drainage of the bladder was actually longer in the second series than in the first (Fig. 2). (Again, the figures being almost identical in the two series—93 and 95—direct comparison may be made.) Three times more patients had their operation during the first six days after admission in series A than in series B. This suggests that the possibility of infection of the urinary tract by prolonging catheter drainage over this short time did not adversely affect the mortality rate.

Prostatectomy Without Retention

During the same periods of time a number of prostatectomies were performed on patients who had not developed urinary retention but who were admitted after out-patient consultation. The numbers corresponding to series A and series B are given in Table IV.

TABLE IV.—*Prostatectomy Mortality With and Without Pre-operative Urinary Retention*

	Series A		Series B	
	Cases	Deaths	Cases	Deaths
After retention	129	20 (15.5%)	128	8 (6.2%)
Without	49	5 (10.2%)	54	3 (5.56%)
Total	178	25 (14.04%)	182	11 (6.04%)

A fall in mortality in the eight-year interval occurred, presumably for the same reasons as are given above. It will be seen that of all patients who had a prostatectomy in this hospital 72.5% (129 out of 178) in series A and 70.3% (128 out of 182) in series B had already suffered from retention before surgery was carried out.

Retention Without Prostatectomy

In Table II is given the mortality of those who came under our care with urinary retention on whom prostatectomy was not performed. The figures are at first sight very high—63.3% in series A and 63.9% in series B. Unlike the mortality for prostatectomy there was no appreciable difference after a lapse of eight years.

The age distribution in the two series is again approximately the same (Fig. 3). What is striking, how-

FIG. 3.—Urinary retention without operation and its mortality (according to age-groups).

ever, is that, although the mortality rate is higher over 75 years of age than under, it is nevertheless high in the younger age-groups. When both series are taken together 72.5% (58 of 80) of those over 75 died, whereas 50.8% (32 of 63) of those under 75 died.

This high mortality figure of 63% in the two series represents those who never became fit for prostatectomy, and in Fig. 4 the times of their deaths after admission are shown. It will be seen that the great majority succumbed within 10 weeks—over 90% in series A and over 80% in series B. Of the 12 in the two series who survived 10 weeks, 11 died within seven months; six of them regained normal micturition and became problems in medical management only; five retained their tubes. The remaining patient, having declined prostatectomy, lived at home for 18 months with his suprapubic tube and was readmitted to hospital shortly before he died.

The 37% in each series who recovered after bladder drainage and without prostatectomy were those who

regained normal micturition after a few days and for whom, despite prostatic enlargement, surgical treatment was not indicated. In this group were the patients with carcinoma who responded to oestrogens; the suprapubic catheter, which was usually used in such cases, was removed as soon as normal micturition was restored.

FIG. 4.—Duration of bladder drainage before death in urinary retention without operation. (Also four cases in series A and eight cases in series B with drainage over 70 days.)

Causes of Death

An analysis of the causes of death in both series has been made in Table V; 36 cases in series A and 29 in series B were confirmed by post-mortem examination

TABLE V.—*Causes of Death After Urinary Retention*

	Cardiac Failure		Cerebro-vascular Accident		Pneumonia		Alimentary Disease		Pyelonephritis		Haemorrhage		Renal Failure		Total	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Prostatectomy	2	5	—	1	2	—	—	—	9	2	7	—	—	—	20	8
No operation	13	19	8	9	9	10	3	3	10	3	1	—	1	2	45	46
Total ..	15	24	8	10	11	10	3	3	19	5	8	—	1	2	65	54

Those who died from cardiac failure did so because of hypertension, myocardial ischaemia, or valvular disease. The deaths from pneumonia were consequent upon a chronic bronchitis or bronchiectasis or, in one case, a bronchial carcinoma. Cerebral deaths were due to vascular thrombosis or haemorrhage. Alimentary causes of death were carcinoma, diverticulitis, or peritonitis.

The illness which caused the patient to take to his bed and so precipitated a urinary retention was usually the one which led to his death. In some cases, however, infection or haemorrhage occurred in the urinary tract of sufficient severity to result in the death of an otherwise fit man. To state a *single* cause of death in many patients is not easy, but emphasis has been placed upon the initiating cause of the terminal illness with special note taken of whether infection of the urinary tract or haemorrhage was primarily responsible.

Of the 20 prostatectomy deaths in series A, 16 had either a severe local infection with a pyelonephritis or a post-operative haemorrhage. In series B only two out

of eight were so affected. The causes of death in the six remaining cases in series B were cerebral haemorrhage, myocardial infarction (2), and acute heart failure, while two others developed cardiac arrest during operation; both these last two suffered from cor pulmonale and were perhaps risky choices for operation.

A reduced incidence of infection and haemorrhage in recent years was also found in those who merely had bladder drainage. When series B is compared with series A, there were 3 cases in 46 as against 11 in 45.

It is interesting to note that of the five deaths which occurred after prostatectomy, at the time of series A, in patients who had not suffered retention (Table IV), one died from severe infection and one from secondary haemorrhage. Of the three at the time of the second series one succumbed to a cerebral embolus from infective endocarditis, one to a pneumonia and chronic bronchitis, and the third was mentally confused before operation. Looking back, none should have been selected for surgery.

There is no doubt that renal infection may hasten the death of an otherwise ill man, and it is equally certain that the very ill man is more prone to develop such infection from his indwelling catheter during the last few days of life. But it is clear from our analysis that the majority of deaths which followed urinary retention without prostatectomy were due to causes outside the urinary tract. In the first series 33 out of 45 (73.3%) died from disease unrelated to the urinary tract and in the second series 41 out of 46 (89.1%).

Discussion

In comparing the two series of patients with urinary retention it is evident that the selection of cases for operation has not varied appreciably. Prostatectomy was performed in approximately 64% of both series. There has been no greater boldness with increasing experience and with the acquisition of new techniques—contrary to our impressions.

A significant fall in prostatectomy mortality has occurred from 15.5% to 6.2%. This fall is apparently mainly due to a much-reduced incidence of severe urinary infection and secondary haemorrhage. A large number of men with retention still die without becoming fit for prostatectomy and in many the retention is merely an episode in a terminal illness. Nevertheless, they often reach the surgeon before the physician and present him with a difficult problem in medical care. We are dealing with a group of patients in whom the risks of operation are great.

Urinary Infection as a Cause of Death

The fact that almost all patients in both series had catheter drainage means that infection was probably introduced into the urinary tract before operation. However, recent emphasis on the scrupulous care needed in the use of the catheter which drains the bladder is reaping its reward. The *Lancet* (1956) stated that there were "three potential killers" after prostatectomy—bleeding, infection, and "collapse of the patient's morale." The first two are certainly valid causes of death, but the third probably represents merely a mental reaction to the other two.

These two factors no longer play such a large part in prostatectomy deaths as they used to do. A similar decline in deaths from infection has occurred in those patients with urinary retention who merely have catheter

drainage. And if in this second group the mortality has been, and still is, very high it is not because the patient has to live for several weeks with an indwelling catheter, but because the medical disorder which precipitates the urinary retention so often ends fatally.

Thomson-Walker's (1921) dictum that the mortality of the "catheter life" is higher than that of prostatectomy is still true to-day, but it must be interpreted differently.

The Medical Factor

If it may be said that the infective hazards of prostatectomy are being eliminated, there will always be a limit to what can be done in the medically unfit. Many patients with urinary retention reach the surgeon during an attack of acute bronchitis, after a coronary or cerebral thrombosis, or with a moderate degree of heart failure. They respond well to treatment, undergo a prostatectomy, and are discharged fit. But by and large, if it is some *advancing* medical disorder which initiates the urinary retention and brings the patient to the surgeon, that disorder will be the cause of his death within about two months. Careful pre-operative preparation will be rewarded with some unexpected and gratifying recoveries in these ill men; but, even so, in recent years we have noticed that some of them die a few weeks after returning home, from an exacerbation or recurrence of the medical condition which brings them to hospital in the first place.

A 69-year-old man suspected of having a bronchogenic carcinoma successfully underwent a prostatectomy. His immediate post-operative recovery was associated with a long period of hypotension, which we could not then explain, but, apart from this, nothing unusual occurred and he returned home a fortnight later. Within a few weeks he was back in hospital with a paraplegia and died from a carcinoma of the bronchus; necropsy revealed multiple secondary deposits, including large ones in both suprarenal glands. Another patient, 74 years old, after eight weeks' pre-operative treatment for a severe recurring bronchitis and heart failure, recovered quickly from his prostatectomy and returned home three weeks later. His bronchitis soon recurred and he died in hospital two months after his operation.

Significance of Urinary Retention

The number of patients undergoing prostatectomy who have already suffered from urinary retention probably varies remarkably from one hospital to another. Salvaris (1960) showed an incidence of 25% retention (1,200 cases) for the urological hospitals in London. In each of our own two series the figure was over 70%. However, in reports on prostatectomy this fact is often not stated, so we do not know the kind of patients whom the surgeon is treating.

It has often been recorded that mortality is higher in prostatectomy if retention has occurred (Riches, 1954; Ellis and Leatherdale, 1958; Salvaris, 1960). We, too, have noticed it (Table IV), but in both of our series the difference is small. That urinary infection may be introduced by the catheter and increases the likelihood of complications there is no doubt (Lloyd-Davies, 1954; Miller *et al.*, 1958), but such infection can be controlled and should not cause death. From our own investigations death occurs not because a catheter has been used but because so many of those who develop urinary

retention are already suffering from a severe cardiovascular or respiratory disease.

We shall always be faced with the problem of selection of cases for prostatectomy from among ageing men whose health is seriously impaired. If after three or four weeks of the best medical treatment improvement has occurred and morale is high, operation should be safe and is worth undertaking even though the patient's expectation of life is very limited.

Between our first and second series of cases we abandoned the permanent suprapubic cystostomy in the treatment of urinary retention and we have not regretted it, for it is a token of the surgeon's despair. An indwelling Riches suprapubic or Gibbons urethral catheter, if carefully managed, can be retained for many weeks, and it leaves the way clear for a safe prostatectomy.

Summary

Two series of 200 cases each of urinary retention due to prostatic obstruction have been analysed. About 64% of each of these came to prostatectomy. Two-thirds of the remainder in each series died without being fit for operation.

After an eight-year interval the mortality of those selected for prostatectomy fell from 15.5% to 6.2%.

Infection and haemorrhage, major causes of death in those who underwent operation in the first series, played a much less significant part in the second series.

Cardiovascular, respiratory, and cerebrovascular disorders, which often precipitate urinary retention, have become the most frequent causes of death after prostatectomy. They also account for the majority of deaths of those with urinary retention who never become fit for surgical treatment.

We would like to acknowledge the work of three ward sisters—Miss M. Armstrong, Miss E. M. Brown, and Miss E. S. Stewart—without whose kindness and skill so many old men would never have regained their health. We also thank Mr. F. D. Breslin for his help in preparing this paper, and Mr. H. G. Hanley, consultant urologist, under whose general supervision all patients were admitted.

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A new British Standard for antral trocars and cannulae (B.S. 3348:1961) has been prepared. They are specified in sets of sizes 6, 7, 8, and 9 designated by the Charrière gauge. Basic requirements for design are laid down and the small Luer conical fitting has been made the standard fitting for connexion of the tubing mount to the cannula. Copies may be obtained from the British Standards Institution, Sales Branch, 2 Park Street, London W.1, or from Coronation House, Market Street, Manchester 1 (price 3s. each, postage extra to non-subscribers).

C

EFFECT OF LOW-CALCIUM DIET ON URINARY CALCIUM IN OSTEOPOROSIS*

BY

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We have suggested elsewhere (Nordin, 1961) that osteoporosis could be due to prolonged negative calcium balance arising from failure of the individuals concerned to adapt to their calcium intake. The mechanism of adaptation to low calcium intakes is not fully understood but appears to consist of two components—an improvement in calcium absorption and a reduction in calcium excretion (Malm, 1958). So far as urinary calcium is concerned, we have previously reported (Nordin, 1961) that patients with osteoporosis appear to be less able than normal subjects to reduce their urinary calcium on a low-calcium diet and have suggested that this might be a contributory cause to rather than the result of their disease.

The present paper reports the effect of a low-calcium diet on urinary calcium excretion in 13 normal subjects and 24 cases of osteoporosis.

Methods

Urinary calcium excretion was first measured for two to four days on the ward diet. The subjects were then given a low-calcium diet containing not more than 200 mg. of calcium for 10 days, and the urinary calcium was re-measured in the final two or three days of this 10-day period.

The normal subjects were ward patients without evidence of metabolic bone disease, in the majority of whom x-ray films had shown a normal skeletal status. Their ages ranged from 47 to 72 years and they consisted of seven males and six females.

The cases of osteoporosis were diagnosed by the radiological method of Barnett and Nordin (1960), which implies that they were all relatively severe cases. Seventeen were cases of spinal or "mixed" osteoporosis and seven were cases of peripheral osteoporosis. Their ages ranged from 49 to 79 years and they consisted of 4 males and 20 females.

Calcium was measured in the urine by titration with ethylenediamine tetra-acetic acid in an EEL titrimeter, using ammonium purpurate as the indicator after removal of phosphate in an ion-exchange column. Creatinine was estimated by the method of King and Wootton (1956).

Results

The 24-hour calcium excretion in the normal and osteoporotic subjects on the ward and low-calcium diets is shown in Fig. 1. The mean values are given in Table I. The mean calcium excretion of the normal subjects on the ward diet was 231 mg./24 hours and on the low-calcium diet 167 mg./24 hours. The difference

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