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Bilharziasis and the Kidney

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BILHARZIASIS AND THE KIDNEY

Introduction

The association between schistosomiasis and disease of the kidneys is known to have existed for over 3,000 years because in 1911 Ruffer, examining the kidneys of Egyptian mummies of about 1,500 years before Christ, was able to demonstrate the presence of ova of *S. haematobium*. Unfortunately, the embalmers' methods precluded examination of the lower urinary tract, but we know from writings on papyri of the same period that haematuria was a common symptom among the ancient Egyptians.

Since the work of Bilharz in 1851, who demonstrated the organism responsible for the first time, it has been recognised that the association between schistosomiasis and renal disease is an indirect one and that direct invasion of the renal parenchyma by the parasite is uncommon.

The renal disease arises by the effects of back pressure of urine due to damage of the lower ends of the ureters (fig. 1). In general, schistosomiasis appears to be a self-limiting disease and the majority of sufferers do not develop renal effects and recover spontaneously provided the lower ends of the ureters are not seriously involved.

Early this century the work of Madden (1907), Day (1911), Hamilton Fairley (1919, 1 and 2), Ali Bay Ibrahim (1923), Girges (1934) and others in Egypt suggested that bacterial superinfection of the urine is a common sequel to urinary schistosomiasis. Fig. 2 shows three possible ways in which schistosomiasis may affect the renal substance. Firstly, simple pressure damage of the uninfected kidney may occur. Secondly, the presence of schistosomiasis of the lower urinary tract may favour the development of bacterial infection of the urine without actual invasion of the renal substance by micro-organisms. Thirdly, pressure damage plus the presence of an infected urine may lead to the invasion of the renal substance by bacteria causing pyelonephritis.

It has been generally held that the last is a common method of production of renal disease in urinary schistosomiasis. Recent work in parts of the world where there is no schistosomiasis (Beeson, 1967) suggests that damage of the bladder mucosa impairs its bactericidal properties and provides a source of entry of bacteria into the lower urinary tract. This may subsequently cause

ascent of infection and damage of the kidneys by pyelonephritis. The theory of ascending infection is, therefore, an attractive hypothesis of the pathogenesis of renal disease in urinary schistosomiasis. If the hypothesis were true, we would expect a much higher prevalence of bacterial infection of the urine in patients with urinary schistosomiasis than in groups of patients without this disease. Unfortunately, there is little published evidence of the prevalence of bacterial infection in the urine in patients with urinary schistosomiasis, but Abdallah (1946) and Gelfand (1950) both found a high prevalence of bacteriuria in patients with urinary schistosomiasis (Table 1).

	PATIENTS	POSITIVE CULTURES
Urinary schistosomiasis	150	34
No schistosomiasis	144	6
(Abdallah, 1946)		
Urinary schistosomiasis	50	14
(Gelfand, 1950)		

Table 1. Presence of positive urine cultures in patients with urinary schistosomiasis.

Since this work was done it has been recognised that certain criteria must be fulfilled before a positive bacterial culture of urine can be considered to have clinical significance. In 1956, Kass demonstrated that it was possible to count the number of living bacteria in urine and to relate the viable bacterial count thus obtained to the likelihood of infection of clinical significance. He showed that if two successive urine specimens had viable bacterial counts of 100,000 organisms per ml. or more there was a 95 per cent certainty of urinary infection of significance to the patient. If the count was less than this it was likely that the urine specimen had been contaminated, either during its collection or during the period elapsing between its collection and culture being carried out; urine is an ideal culture medium for micro-organisms which multiply rapidly if the specimen is stored for any length of time.

The accuracy of bacterial counts depends on the care with which urine specimens are obtained. Ordinary specimens of urine are unsatisfactory because they may become contaminated by micro-organisms derived from the skin around the urethral meatus; therefore, careful cleansing of the skin is done before micturition, and the mid-stream portion of the urine only is collected and refrigerated if it cannot be cultured immediately.

A simple technique for counting micro-organisms in urine has been devised by Leigh and Williams (1964). Blotting-paper strips of standard size are used to make impressions on MacConkey agar of absorbed urine (fig. 3). Micro-organisms are filtered out on the surface of the blotting-paper and are taken up by the culture medium when it is applied to them. Fig. 4 shows plates incubated for 24 hours after paper impressions have been made in this way. The plate on the left shows sterile urine; the centre plate shows three urines with bacterial counts of more than 100,000 per cu. mm.; the plate on the right shows probable contaminants. The blotting-paper can be calibrated simply by standardisation with urines containing known quantities of micro-

organisms and fig. 5 shows the standardisation of the paper used in this study. A count of 20 colonies or more on the paper impression is equivalent to 100,000 organisms per ml. of urine. This technique is very easy to perform and it is possible to examine accurately a large number of urine specimens in a short time.

	BACTERIURIA %		
	MALE	FEMALE	SCHISTOSOMIASIS %
Wales and Jamaica	0·5	4·4	?0 (>4,000)
U.S.A.	0·4	3·3	0 (>4,000)
Nigeria	1·4	4·2	57 (638)
Tanzania	10% overall		42 (not stated)
Zanzibar	2·7	0	100 (46)

Table 2. Published rates of prevalence of bacteriuria in regions of endemic urinary schistosomiasis compared with values in non-schistosomal areas (see text). Figures in brackets indicate the total number of patients in each group.

Very few studies have been done of the prevalence of bacteriuria in areas of endemic urinary schistosomiasis using comparable techniques. Table 2 relates the only previously published results to counts obtained in non-schistosomal populations in Wales, Jamaica and the U.S.A. (Kass, 1963, 1966). In Nigeria (Pi-Sunyer *et al.*, 1965) and Zanzibar (Chopra *et al.*, 1967) the prevalence of bacteriuria was not high although schistosomiasis was common. In Tanzania (Forsyth and Bradley, 1966) the figures suggest a greater prevalence of bacteriuria. Apart from the Zanzibar group, which was very small, bacteriuria was more common in females than in males, presumably owing to the shortness of the female urethra and the greater chance of entry of bacteria.

It is apparent that the published evidence relating bacteriuria to schistosomiasis is conflicting. There is even no general agreement that bilharziasis is a serious disease (Ansari, 1967). The present study was, therefore, directed to define firstly the role of bacteriuria in schistosomiasis and, secondly, the importance of schistosomiasis as a cause of renal disease in Rhodesian African patients.

Preliminary Work

A pilot study was undertaken in African out-patients to determine the prevalence of significant bacteriuria and to try to relate this to urinary schistosomiasis. Table 3 relates bacteriuria in 204 unselected out-patients to the findings in comparable groups of out-patients in America (Kass, 1956), England (O'Sullivan *et al.*, 1961) and Sweden (Forkman, 1962). It shows that in African patients there was no excess of bacteriuria over those in non-schistosomal areas.

OUT-PATIENTS	BACTERIURIA % MALE	FEMALE	
United States (Kass, 1956)	4·5	5·5	(439)
England (O'Sullivan *et al.*, 1961)	2	12	(150)
Sweden (Forkman, 1966)	7 overall		(99)
Rhodesia	4	5·9	(204)

Table 3. Bacteriuria rates in Rhodesian African out-patients related to comparable populations without urinary schistosomiasis. Figures in brackets indicate the total number of patients in each group.

Urinary schistosomiasis may be detected in a number of ways; firstly, by the presence of ova in the urine (fig. 6).

Out-patients	204 (100%)
With ova	32·8%
With bacteria	5·9%
BACTERIURIC SUBJECTS:	
With ova	25%
Without ova	75%

Table 4. The prevalence of excretion of ova was no greater in bacteriuric than in non-bacteriuric out-patients.

Table 4 relates bacteriuria to the excretion of ova in African out-patients. There is no greater prevalence of excretion of ova in those with bacteriuria.

Another method of diagnosing urinary schistosomiasis is by calcification of the lower urinary tract apparent on X-ray (fig. 7) due to myriads of calcified schistosome ova.

	WITH CALCIFICATION	WITHOUT CALCIFICATION
Total examined	22	84
With bacteriuria	1	5

Table 5. The presence of radiographically demonstrable calcification of the lower urinary tract due to schistosomiasis is no greater in bacteriuric patients than in the entire out-patient population at risk.

Table 5 relates the presence of calcification to the presence of bacteriuria and shows that in bacteriuric patients there is no greater proportion of subjects with calcification of the urinary tract. Using these two criteria of the presence of schistosomiasis, therefore, no relationship could be demonstrated in this population between schistosomiasis and bacteriuria.

Following this pilot study it was decided to investigate a much larger population in a mine compound who could be expected to be "well" apart from the presence of urinary schistosomiasis. Men, women and children of all ages were examined. Table 6 relates prevalence of bacteriuria to that in healthy subjects in Wales and Jamaica where there is no urinary schistosomiasis. The similarity in prevalence of bacteriuria amongst these populations of such widely different backgrounds was remarkable. Again, we are unable to demonstrate excessive bacteriuria rates in schistosomal subjects.

	BACTERIURIA %		
	MALE	FEMALE	
Wales (mining)	0·5	4·9	(1129)
Jamaica (urban)	0·5	2·2	(1880)
Rhodesia (mining)	0·7	2·5	(1089)

Table 6. Bacteriuria rates in a "healthy" Rhodesian mining community with endemic urinary schistosomiasis were no greater than the values previously published for comparable non-schistosomal populations (see text). Figures in brackets refer to the total number of subjects in each group.

Fig. 8 relates the presence of bacteriuria to age in female subjects. No significant difference was found in prevalence rates of bacteriuria between the schistosomal and non-schistosomal patients in any age group. In this population an attempt was made to relate the presence of bacteriuria to the presence of schistosomiasis, using the same criteria of excretion of ova and bladder calcification. Table 7 shows, as before, that no relationship exists between the excretion of ova or the presence of bladder calcification and bacteriuria in the subjects examined.

	BACTERIURIA	NO BACTERIURIA
MALES:		
Number	6	39
Excreting ova	0	17
With calcification	1	6
FEMALES:		
Number	6	9
Excreting ova	0	1
With calcification	1	0

Table 7. The excretion of ova and presence of radiographic calcification of the lower urinary tract were no more prevalent in bacteriuric than in non-bacteriuric subjects in a "well" population.

It was particularly noteworthy that amongst 236 schoolchildren under the age of 15 examined in this population, 60 per cent of whom had haematuria, a sign of severe urinary schistosomiasis, no case of bacteriuria was observed.

Part I: Bacteriuria, Pyelonephritis and Schistosomiasis

PATIENTS AND METHODS

It was decided to extend these observations by a detailed study of urinary schistosomiasis in a consecutive series of 1,440 medical in-patients in whom excretory urography and cystoscopy could be performed. Fig. 9 shows typical urographic findings in a patient with renal disease due to urinary schistosomiasis.

The criteria of schistosomiasis were (1) the excretion of ova, (2) the presence of radiographic calcification of the bladder, (3) urographic abnormality (Honey and Gelfand, 1960; al Ghorab, 1968) and (4) the presence of abnormality on cystoscopy. The grading of cystoscopic appearances described by Weinberg and Gelfand (1967) allowed comparison to be made of degrees of severity of urinary schistosomiasis.

In this population an attempt was made to relate the presence of schistosomiasis, not only to bacteriuria, but also to pyelonephritis from bacterial invasion of the kidney. The excretion of white cells in the urine is useless as a diagnostic test of pyelonephritis in the schistosomal population because of pyuria accompanying excretion of ova (Dukes *et al.*, 1967) but the excretion of leucocyte casts (fig. 10) is a means of demonstrating active inflammation of the renal parenchyma (Relman, 1960). It is not specific to pyelonephritis; it is also found in glomerulonephritis and other acute inflammatory conditions of the renal parenchyma, but it is a valuable indication of pyelonephritis in combination with other criteria.

Creatinine clearance (Wootton, 1954) and maximum urine concentration after the administration of Pitressin (Wrong, 1963) were used to demonstrate impairment of renal function. These are also non-specific tests and again, have to be taken in conjunction with other indications of pyelonephritis. The criteria employed to define pyelonephritis in this series were: (1) the presence of bacteriuria in ureteric urine determined either by direct ureteric catheterisation as described by Stamey *et al.* (1963) or by obtaining ureteric urine during diuresis following bladder wash-out as described by Fairley *et al.* (1966); (2) presence of cellular casts in the urine; (3) dilated calyces and related narrowing of the renal parenchyma on excretory urography (Hodson, 1959); (4) impaired renal function and (5) renal biopsy carried out in consenting subjects. Renal biopsy is an imperfect method of diagnosing pyelonephritis because of the patchy distribution of the disease and the difficulty of deciding whether the histological appearances are due to bacterial invasion of the renal parenchyma or to chronic, non-specific renal disease (Heptinstall, 1967). Multiple tests are, therefore, necessary to diagnose pyelonephritis (Hutt *et al.*, 1961) and in this investigation, pyelonephritis was not considered to be confirmed unless at least two of these criteria were fulfilled.

RESULTS

1. *Bacteriuria*

A total of 592 males and 374 females were investigated for bacteriuria.

Patients who died or were discharged within 48 hours of admission are excluded, and the rates of prevalence are shown in Table 8. They are remarkably low; rates of up to 10 per cent in males and 30 per cent in females have been quoted in hospitals in New England (Kass, 1963) and these low bacteriuria rates may perhaps be explained by the relative youth of the African hospital population whose mean age is less than 35 years. According to the current hypothesis this is a surprising finding in the presence of endemic urinary schistosomiasis.

		BACTERIURIA	
IN-PATIENTS		NUMBER	RATE
MALE	592	10	1·69%
FEMALE	374	12	3·21%

Table 8.

The organisms isolated follow a similar pattern to that described in non-schistosomal areas of the world with *E. coli* predominating (Table 9). Twenty-five per cent of the patients with bacteriuria were found to have pyelonephritis according to the above criteria, confirming the association between pyelonephritis and bacteriuria recognised in non-schistosomal populations.

ORGANISM ISOLATED	CASES
E. Coli	16
K. Aerogenes	2
Str. Faecalis	1
Proteus + *Klebsiella* sp.	1
Ps. Aeruginosa	1
S. Enteritidis	1

Table 9. Types of organism identified in 22 cases of significant bacteriuria in patients in general medical wards.

Fig. 11 analyses the 22 cases of bacteriuria demonstrated amongst this consecutive group of 966 medical in-patients according to the cause determined by investigation of each case. Carcinoma of the bladder and urethritis appeared to be particularly common causes, but in only one instance could schistosomiasis be implicated as a cause of bacterial infection of the urine. This was a patient with primary ureteric dilatation due to urinary schistosomiasis who was found by micturating cystogram to have free vesico-ureteric reflux, and as in cases described by Rosenheim (1963) this was presumably the cause of the bacteriuria. No significant difference was found in the frequency and severity of schistosomiasis between 22 patients with bacteriuria and 25 randomly-chosen control patients who had sterile urine. It was concluded that uncomplicated schistosomiasis did not predispose to bacteriuria.

2. *The Causes of Renal Disease*

The causes of renal disease encountered in medical in-patients are shown in fig. 12. Nephrotic syndrome was the commonest cause of morbidity due to renal disease, but no deaths were due to nephrotic syndrome.

The second most common renal disease, obstructive disease due to

urinary schistosomiasis, carried the highest mortality in this group. Pyelonephritis was almost as common, but carried a much lower mortality.

None of the 11 cases of pyelonephritis could be proved to be due to urinary schistosomiasis. Only one of the 12 cases of obstructive renal disease due to schistosomiasis was found to have bacteriuria on admission to hospital; the rest of them had sterile urine. It thus appeared that this disease was due to the effect of pressure of sterile urine on the renal parenchyma.

In one of these 12 cases pyelonephritis was found to accompany systemic tuberculosis with a localised focus of tuberculosis in the kidney. It followed nephrostomy in another of these patients, but no evidence of pyelonephritis, according to the above criteria, could be found in the other 10 cases.

Five out of these 12 patients died from the effects of their obstructive disease. All of the remaining patients had impaired renal function and it was therefore apparent that this was a serious form of renal disease and one which carried high mortality.

Part II: Schistosomiasis and Obstructive Renal Disease

In view of these results it was felt desirable to examine the role of urinary schistosomiasis as a cause of obstructive renal disease in hospital in-patients.

METHODS

The intravenous pyelograms performed on 200 consecutive hospital in-patients from all units of the hospital were examined at the time they were performed. Particular emphasis was placed on the presence of calyceal dilatation, and the lower urinary tract was scanned for signs of urinary schistosomiasis. All patients with obstruction were examined for bacteriuria and impairment of renal function, and the cause of renal disease was determined as accurately as possible.

RESULTS

Thirty-seven patients were found to have obstructive renal disease and fig. 13 lists the causes. By far the commonest was ureteric obstruction due to urinary schistosomiasis which was more than three times as common as in African patients in Durban (Powell, 1968). Carcinoma of the bladder, which may itself be due to urinary schistosomiasis (Gelfand *et al.*, 1967) was the second most common cause.

Three groups of patients were selected from 200 subjects submitted to urography; (1) the 13 patients with obstruction due to urinary schistosomiasis; (2) 24 with other forms of obstruction and (3) a control group of 26 patients without obstruction selected on a random basis. No greater prevalence of calcification could be demonstrated in the patients without urinary schistosomiasis than in the other groups (Table 10). It was concluded that the presence of calcification in the lower urinary tract was unhelpful as an indication of the likelihood of the presence of renal disease due to schistosomiasis.

		CALCIFICATION
Obstruction from schistosomiasis	13	1
Other obstruction	24	3
Control patients with no obstruction	26	5

Table 10.

Pyelonephritis was sought in the three groups using the criteria previously defined (Table 11). It was found in only one patient suffering from obstruction due to schistosomiasis. This patient had systemic tuberculosis and a localised focus of tuberculosis in the kidney, which is an accepted predisposing cause of pyelonephritis in non-schistosomal populations. Only one case of pyelonephritis was found in obstruction due to causes other than urinary schistosomiasis. No pyelonephritis was found in the control subjects without obstruction. Schistosomal obstruction was not, therefore, found to predispose to pyelonephritis in these patients.

		PYELONEPHRITIS
Obstruction from schistosomiasis	13	1 (T.B.)
Other obstruction	24	1
No obstruction	26	0

Table 11.

Similarly, bacteriuria did not have a higher prevalence in patients with obstruction due to schistosomiasis than in the two other groups (Table 12). Indeed, bacteriuria was not found in any form of obstructive renal disease other than in the presence of the predisposing factors shown in Table 13, of which catheterisation is the most prominent.

		BACTERIURIA
Obstruction from schistosomiasis	13	2
Other obstruction	24	8
No obstruction	26	2

Table 12.

	CASES
Catheterisation	4
Instrumentation	3
Fistula of bladder	2
Calculus of bladder + Carcinoma	1

Table 13. Bacteriuria was not found in any form of obstructive disease other than in the presence of the above causes.

Combining patients in both series, therefore, we have in all 24 patients with obstructive disease due to schistosomiasis. Five died during their admission to hospital at a mean age of only 27 years and three had nephrectomy for acute infection which in two cases was induced by instrumentation and one case was due to tuberculosis. Only six of these patients escaped serious illness during their stay in hospital. This is a measure of the gravity of the disease caused to the kidney by obstruction in urinary schistosomiasis.

Fig. 14 compares renal function tests in patients with obstructive renal disease to patients with renal disease due to other causes. Maximum urinary concentrating power after injection with Pitressin, an indication of renal medullary function, was more severely impaired relative to creatinine clearance in the group with obstructive disease. In other words, patients with obstructive disease have selective impairment of renal medullary function.

On the other hand, no significant difference can be demonstrated in the relationship of maximum urine concentration to creatinine clearance between obstructive disease due to schistosomiasis and obstruction not due to schistosomiasis (fig. 15). These tests reveal no significant difference in impairment of renal function between renal disease due to schistosomiasis and obstruction from other causes.

Discussion

We may summarise these results in fig. 16 which shows that 18 out of 23 cases of obstructive disease due to urinary schistosomiasis were due to simple back-pressure effects caused by sterile urine on a kidney showing no evidence of pyelonephritis (the 24th case was excluded because of the presence of glomerulonephritis). No cases were observed of urinary infection without pyelonephritis, and of the five cases found to have pyelonephritis, three were due to instrumentation, and two to tuberculosis. We must therefore conclude that the hypothesis that renal disease due to urinary schistosomiasis is caused by ascending pyelonephritis is no longer tenable. Renal disease appears to be due to the effects of back pressure and sterile urine on uninfected renal substance. Bacteriuria is an important complication of the obstructive renal disease, but it appears to arise from recognised extrinsic causes and not from schistosomiasis itself.

This has considerable clinical importance because uninfected obstruction is a potentially recoverable condition. It has been shown by Berlyne (1961) that considerable functional improvement can follow relief of even long-standing obstructive hydronephrosis. This means that if we can relieve the obstruction in urinary schistosomiasis we are likely to produce an improvement in renal function. This has been confirmed in other parts of Africa (Lucas *et al.*, 1966 (1) and (2); Chapman (1966); Farid *et al.* (1967); MacDonald and Forsyth, 1968; and MacDonald *et al.* (1968)). In one of our own group of patients a similar dramatic improvement was apparent. This was a little girl of 9 years of age who was admitted to hospital severely uraemic from obstructive renal disease due to urinary schistosomiasis. Following conservative therapy her blood urea fell to normal levels and an I.V.P. showed bilateral hydronephrosis and rather poor concentration (fig. 17). Maximum urine concentrating power at this stage was 300 m.Osm./K., creatinine clearance was less than 30 ml./min. She was treated with Niridazole and seven weeks later had made a remarkable recovery, regaining several pounds in weight and becoming a much more lively child. At this time her I.V.P. showed almost complete disappearance of obstructive features and improved concentration (fig. 18); her creatinine clearance had risen to 60 ml./min., and her urinary concentrating power was now 500 m.Osm./K. after Pitressin.

More recently, it has been demonstrated by Professor Mynors and Mrs. Heather Dukes that even in advanced renal failure due to obstructive disease from urinary schistosomiasis of a severity requiring haemodialysis to maintain life for investigation of the patient to be carried out (fig. 19) if relief of the obstruction can be produced by nephrostomy, appreciable renal function can be recovered. Fig. 20 shows a urogram of a patient who, following nephrostomy preceded by haemodialysis, recovered considerable function of the right kidney; the left kidney, unfortunately, became infected and functionless. Following this procedure the patient's clinical condition improved sufficiently to allow operation to be performed for reconnection of the upper portion of the undiseased part of the ureter to the bladder. Fig. 21 shows the resected

portion of the ureter showing, at the left, a stenosis due to bilharziasis and the presence of a small calculus.

Fig. 22 is a post-operative urogram of the same patient showing the uninfected ureter anastomosed to an isoperistaltic segment of the ileum which has been joined at the lower end to the bladder to form an artificial ureter, a procedure that has been advocated by Weinberg (1968) in patients with severe obstruction of the lower end of the ureters.

Of course, these surgical triumphs are not the way in which we should attack the problem of urinary schistosomiasis. Prevention is better than attempted cure once the ravages have occurred. The next three photographs were taken at a recent symposium on bilharziasis and snail control held by the Blair Research Laboratory in the Lowveld. Fig. 23 shows molluscide being applied to the water of the main irrigation canal on a sugar estate. Fig. 24 shows a molluscide being applied to reed-beds using very simple and relatively cheap apparatus in the boat, and even the stirrup-pump can assist in the control of the snail population which is the intermediate vector of bilharziasis (fig. 25).

There is already evidence of the efficacy of snail control measures in reducing both the prevalence and the severity of infection with urinary schistosomiasis in endemic areas (Clarke, 1965). This work will have to be combined with treatment on a large scale of populations infected by urinary schistosomiasis if adequate control is to be achieved. It is clear that eradication of this disease cannot be achieved in this country for many years, and, in the meantime, we are left with problems such as those already illustrated of the cure of renal disease arising from urinary schistosomiasis.

How important is this condition to the community as a whole? Unfortunately, the information we have at the moment is only indirect. It is derived from the hospital population which cannot be assumed to reflect accurately in microcosm the general population of the country, for patients come to hospital because they are ill and considerable selection, therefore, takes place.

Fig. 26 is a "cake" diagram of the different types of disease encountered as causes of death amongst about 1,440 medical in-patients observed. Cardiac disease forms the largest single slice of the cake closely followed by all forms of malignant disease. I have charted malignant disease other than primary hepatic carcinoma separately because hepatic carcinoma is by far the commonest single form of malignant disease in the African population. Bacterial and virus infections still claim a considerable section of the cake although malaria and amoebiasis are now very well controlled, but renal disease is the fourth largest single component of the causes of death observed in our medical in-patients and, therefore, has to be taken seriously, especially as so many other causes of death, namely malignant disease and a large proportion of cardiac disease, have no known aetiology. Many causes of renal disease are recognised and can be treated.

Fig. 27 shows 14 cases of renal disease broken down according to cause. By far the largest slice of the cake here is due to obstructive disease due to urinary schistosomiasis. Pyelonephritis and hypertension occupy a small fraction. Chronic non-specific renal disease of unknown aetiology occupies a large

slice and acute oliguric renal failure is perhaps over-represented in this series because of our interest in this condition.

We have, therefore, a considerable proportion of renal disease which is preventable. Perhaps the significance of these figures can be better appreciated by comparing obstructive renal disease from urinary schistosomiasis with another better-known disease, carcinoma of the bronchus (Table 14). It is true that a falsely low impression of the death rate due to carcinoma of the bronchus can be gained in the hospital population because many patients are discharged to die, but an appreciable proportion of these cases have been operated upon successfully or given prolonged remission by palliative therapy. It is clear that we are dealing with a renal condition whose morbidity and mortality is of the same order of magnitude as that of a familiar malignant disease. This emphasises the clinical importance of obstructive renal disease due to urinary schistosomiasis. It is a treatable condition as well as a preventable one. How can we screen patients for the presence of this disease so that we can treat them effectively before permanent renal damage occurs? The results of the renal concentration tests in this study offer pertinent information. Sixteen out of the 17 cases of obstructive renal disease due to urinary schistosomiasis had a maximum urine concentration of 700 m.Osm./K. (specific gravity 1,022) or less, after the injection of Pitressin.

	PER 1,000 ADMISSIONS	
	CASES	DEATHS
Obstructive renal disease due to schistosomiasis	8·33	3·47
Carcinoma of Bronchus	13·19	2·08

Table 14. Morbidity and mortality rates of obstructive renal disease due to urinary schistosomiasis were of the same order of magnitude as those of a familiar malignant disease.

The use of Pitressin simplifies the measurement of renal concentrating power because full renal concentration following fluid deprivation is only achieved after a period of 30 hours or more (Miles *et al.*, 1954). This is a very severe trial to impose on any patient who is ill.

The test employed in this study consists of giving patients in a normal state of hydration 5 units of Pitressin tannate in oil subcutaneously at 6 p.m., and measuring the osmolality or the specific gravity of the first specimens of urine produced on the following morning (Wrong, 1963). Provided that instructions are given to the patient to avoid excessive fluid intake, there is no danger of water intoxication and there is good evidence that this is a safe test of renal function in urinary schistosomiasis (Talaat, 1948). This is suggested as a potential screening test for the presence of renal disease in patients with bilharziasis. It is not, of course, a specific test for obstructive renal disease; it is positive in many diseases of the renal parenchyma, but it could be used to detect patients who should be investigated more thoroughly for the presence of obstructive renal disease due to urinary schistosomiasis.

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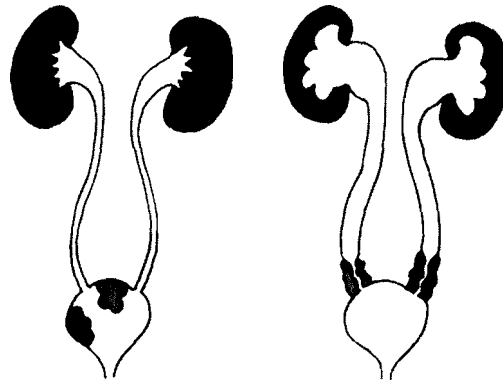

Fig. 1.

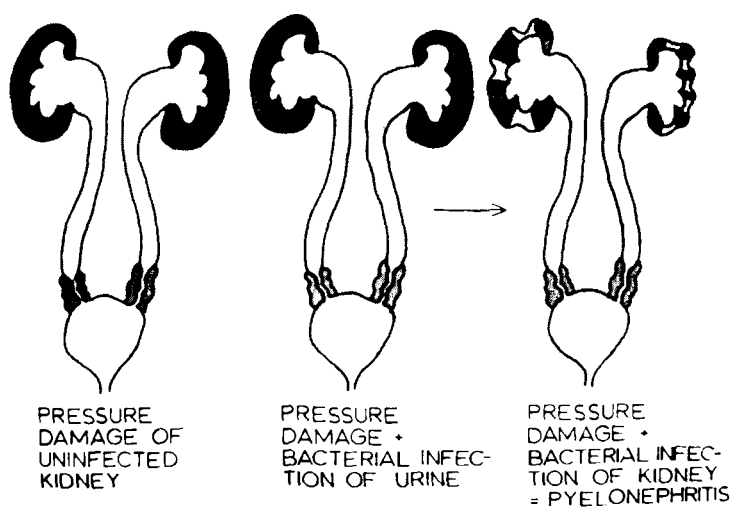

Fig. 2. Possible methods of production of renal damage by urinary schistosomiasis.

Fig. 3. Method of quantitative urine culture using a blotting-paper strip folded to make a ½ × ¼ in. standard impression on MacConkey agar. (Leigh and Williams, 1964.)

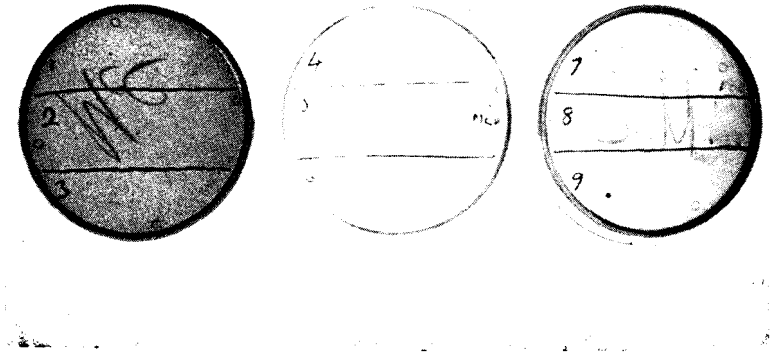

Fig. 4. Colonies ready for counting after incubation of plates for 24 hours (see text).

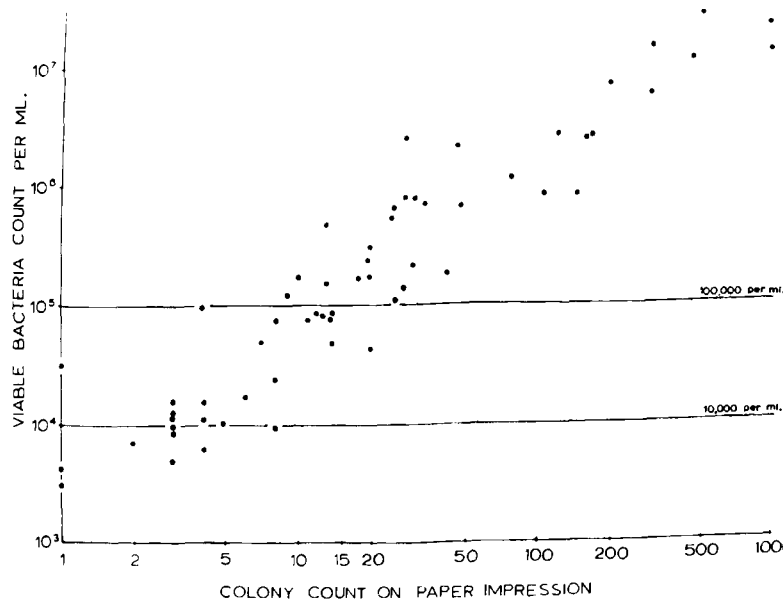

Fig. 5. Calibration of blotting-paper ("Gateway Quicksorb") used for performing viable bacterial counts in this study.

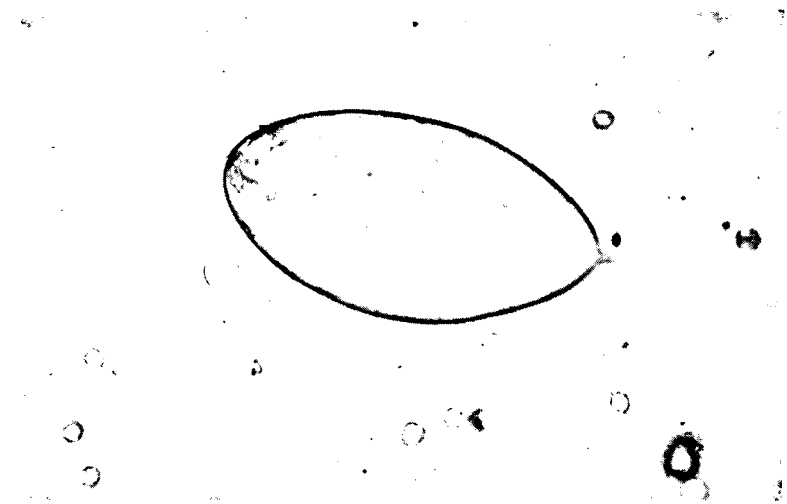

Fig. 6. An ovum of *S. haematobium* in urine from an infected patient, together with leucocytes and red blood cells.

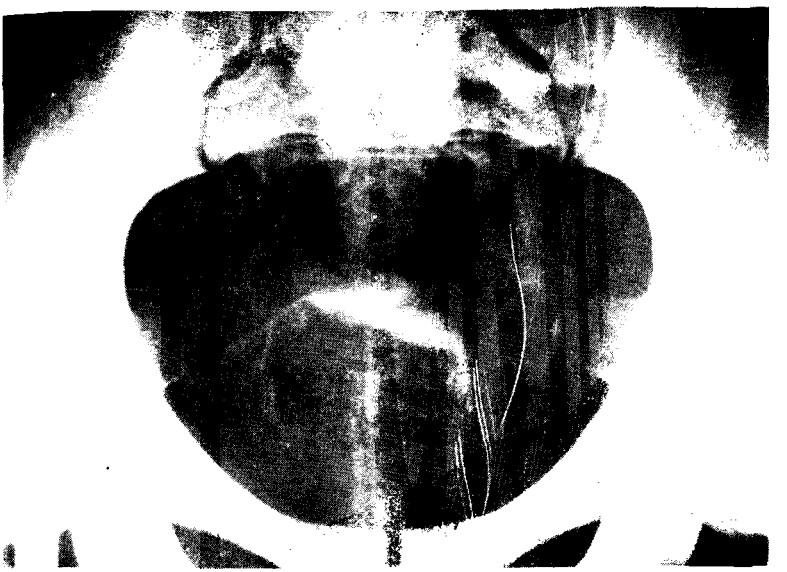

Fig. 7. Plain radiograph of a patient with severe urinary schistosomiasis. The bladder is calcified, as are the lower ends of both ureters, which are enormously dilated.

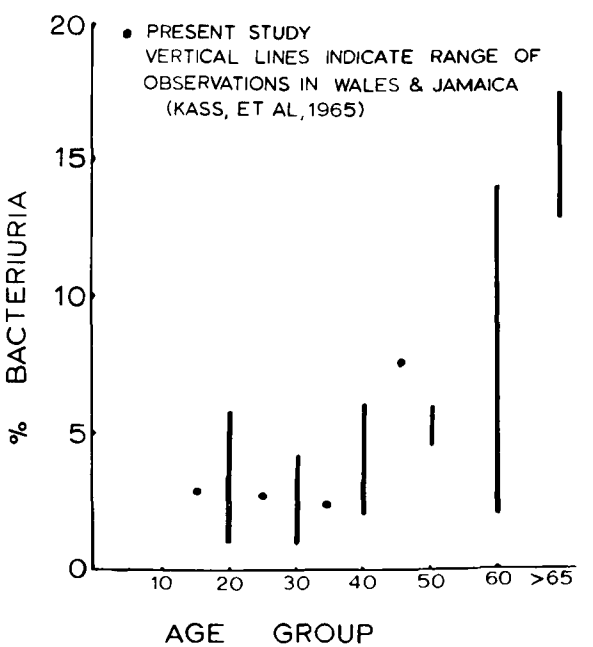

Fig. 8. Bacteriuria rates in female volunteers from a Rhodesian African mining community, according to age, compared with published values in non-schistosomal populations. (Data from Kass, E. H., *et al.* (1965) in *Progress in Pyelonephritis*, p. 3. F. A. Davis Co., Philadelphia.)

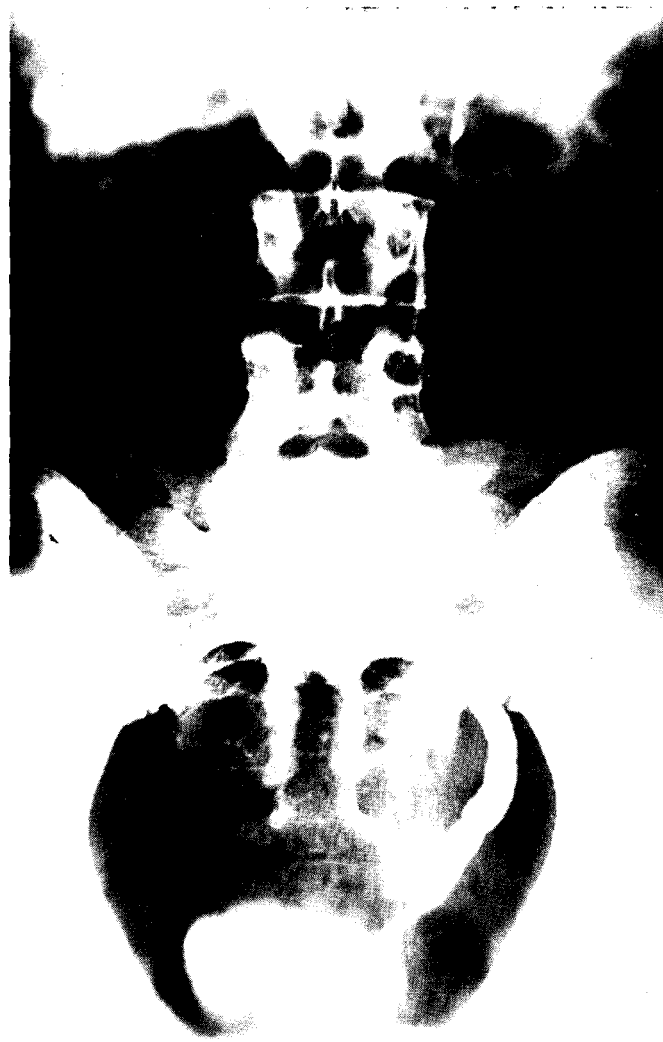

Fig. 9. Excretory urogram of a patient with ureteric damage due to urinary schistosomiasis. The right kidney is hydronephrotic and the ureter does not fill. The left lower ureter shows irregularity and terminal narrowing. Its filling persists in all films.

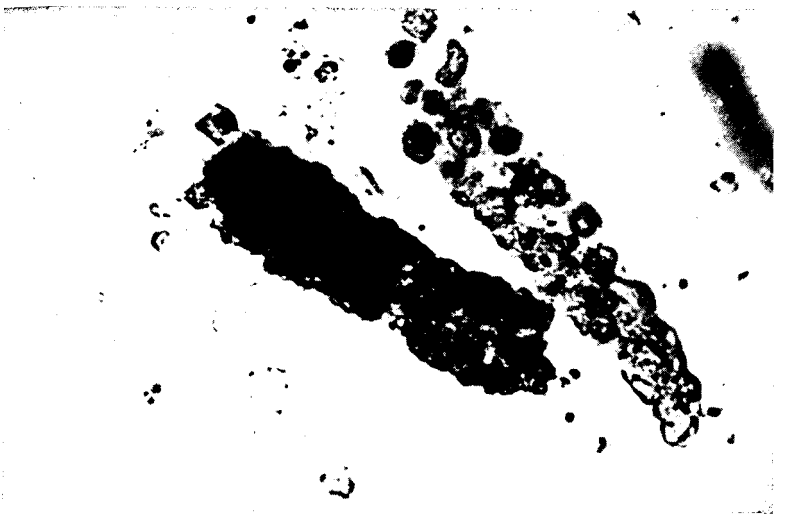

Fig. 10. Cellular casts in the urine of a patient with pyelonephritis.

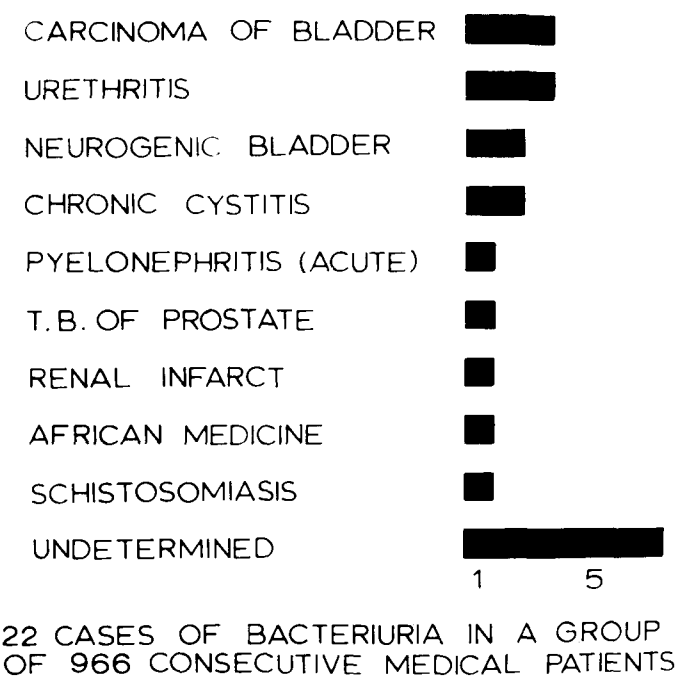

Fig. 11

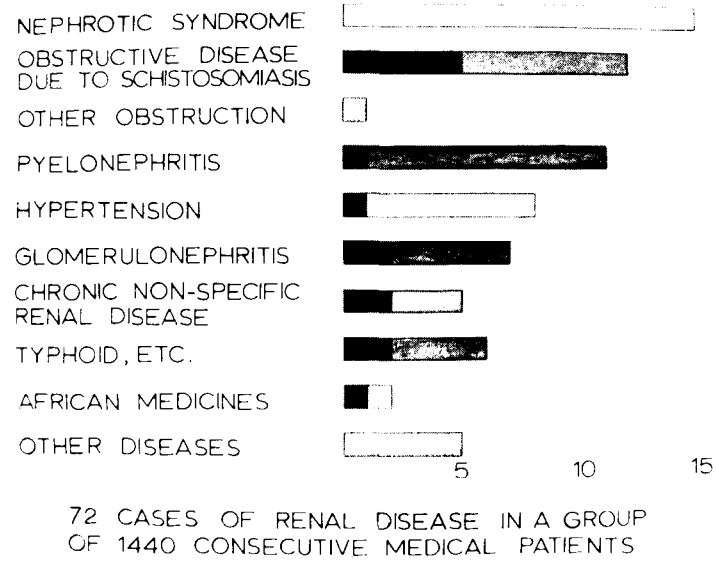
NEPHROTIC SYNDROME
OBSTRUCTIVE DISEASE DUE TO SCHISTOSOMIASIS
OTHER OBSTRUCTION
PYELONEPHRITIS
HYPERTENSION
GLOMERULONEPHRITIS
CHRONIC NON-SPECIFIC RENAL DISEASE
TYPHOID, ETC.
AFRICAN MEDICINES
OTHER DISEASES
5
10
15
72 CASES OF RENAL DISEASE IN A GROUP OF 1440 CONSECUTIVE MEDICAL PATIENTS

Fig. 12.

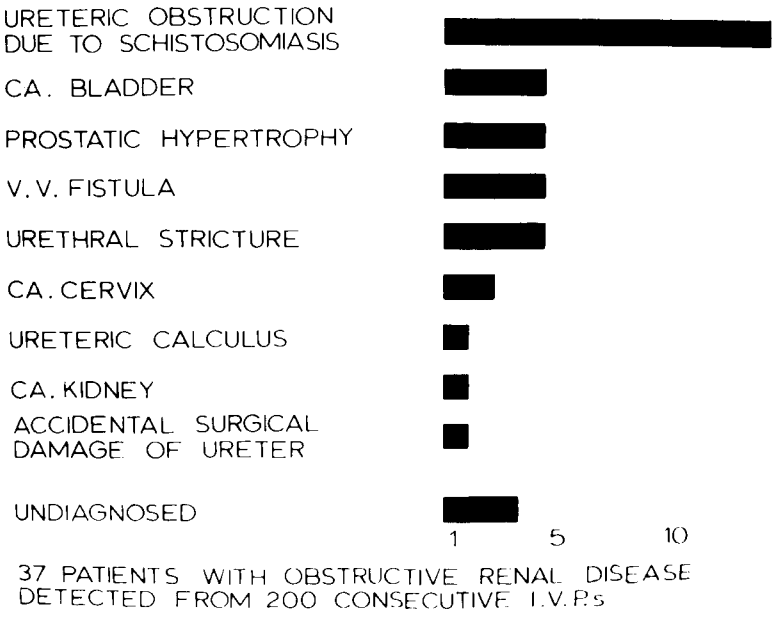
URETERIC OBSTRUCTION DUE TO SCHISTOSOMIASIS
CA. BLADDER
PROSTATIC HYPERTROPHY
V.V. FISTULA
URETHRAL STRICTURE
CA. CERVIX
URETERIC CALCULUS
CA. KIDNEY
ACCIDENTAL SURGICAL DAMAGE OF URETER
UNDIAGNOSED
1
5
10
37 PATIENTS WITH OBSTRUCTIVE RENAL DISEASE DETECTED FROM 200 CONSECUTIVE I.V.Ps

Fig. 13.

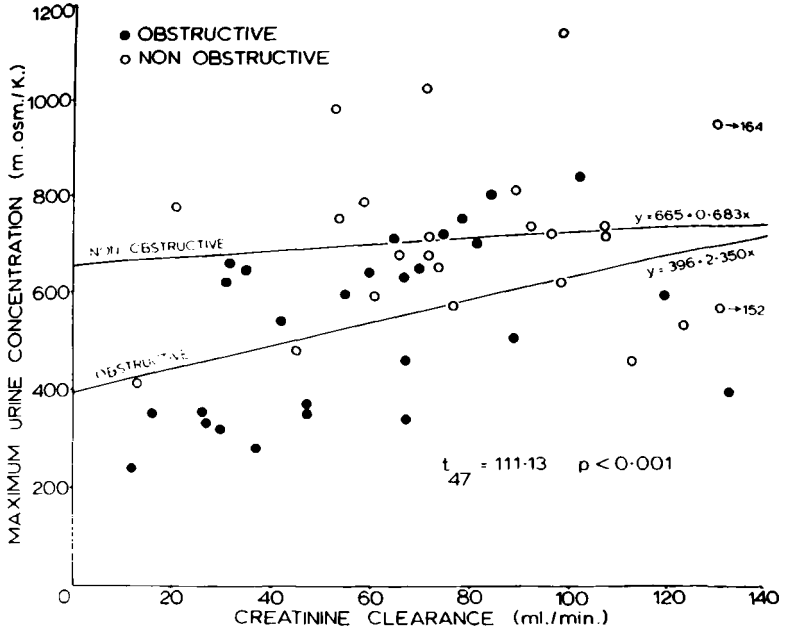

Fig. 14. Maximum urinary concentrating power after Pitressin was significantly lower in patients with obstructive renal disease than in those without obstruction, when related to glomerular filtration rate. (G.F.R. measured by creatinine clearance.)

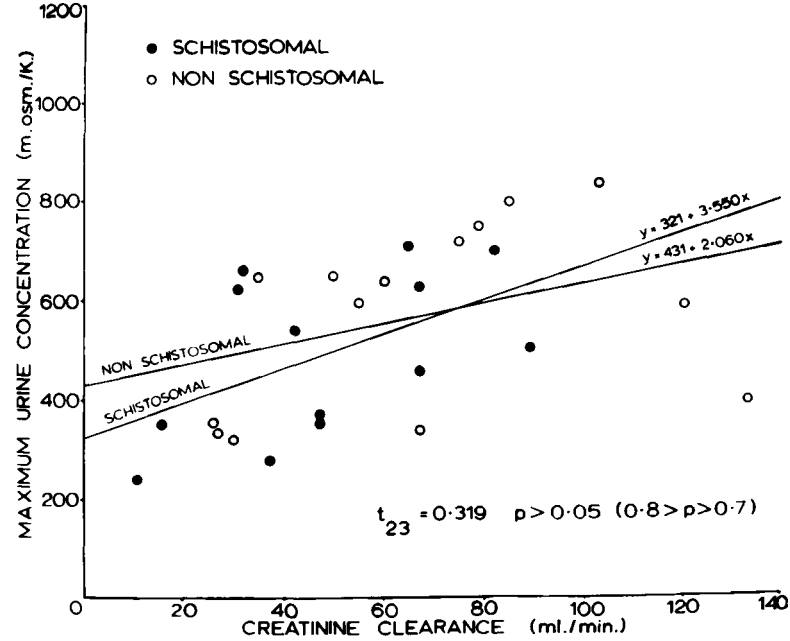

Fig. 15. Impairment of renal concentrating power relative to reduction in G.F.R. did not differ significantly between renal disease due to schistosomiasis and obstructive disease due to other causes.

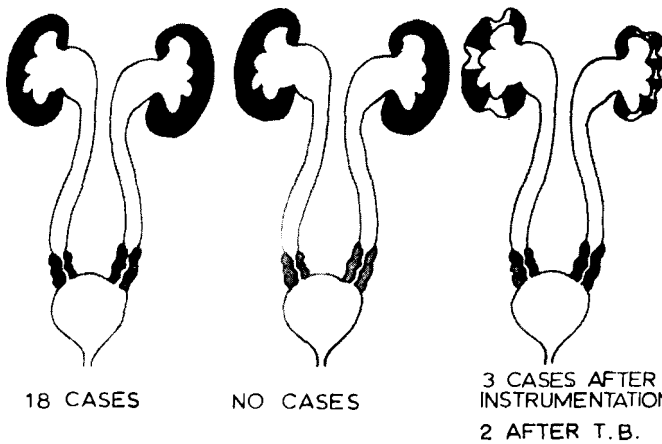

Fig. 16. These observations support the hypothesis that renal disease due to urinary schistosomiasis is caused by increased pressure of sterile urine upon uninfected renal parenchyma.

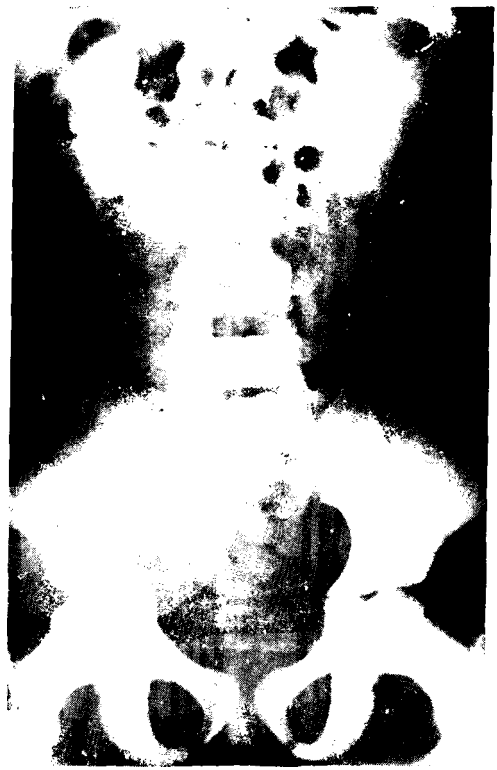

Fig. 17. Excretory urogram in a 9-year-old girl with obstructive renal disease due to urinary schistosomiasis.

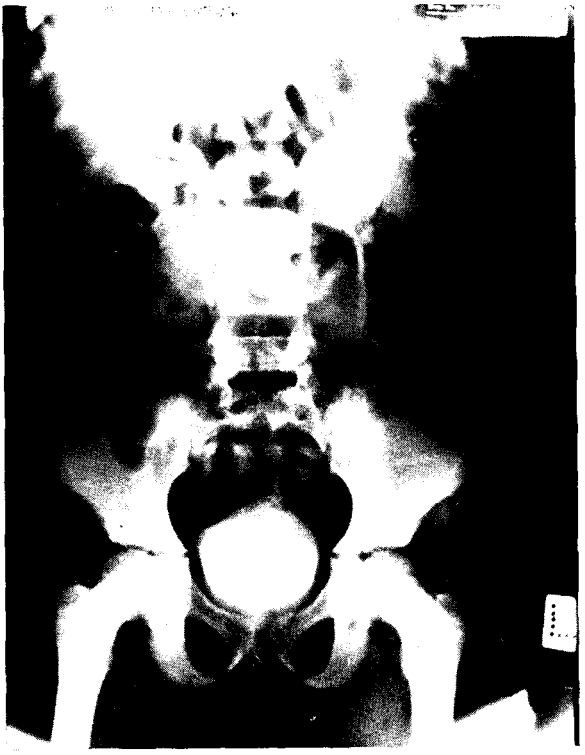

Fig. 18. Urogram in the same patient seven weeks after treatment with Niridazole.

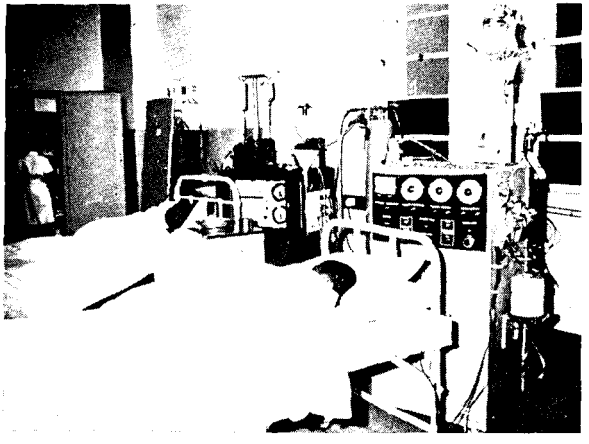

Fig. 19. Patient with renal failure due to schistosomiasis being prepared by haemodialysis for operation to relieve the obstruction.

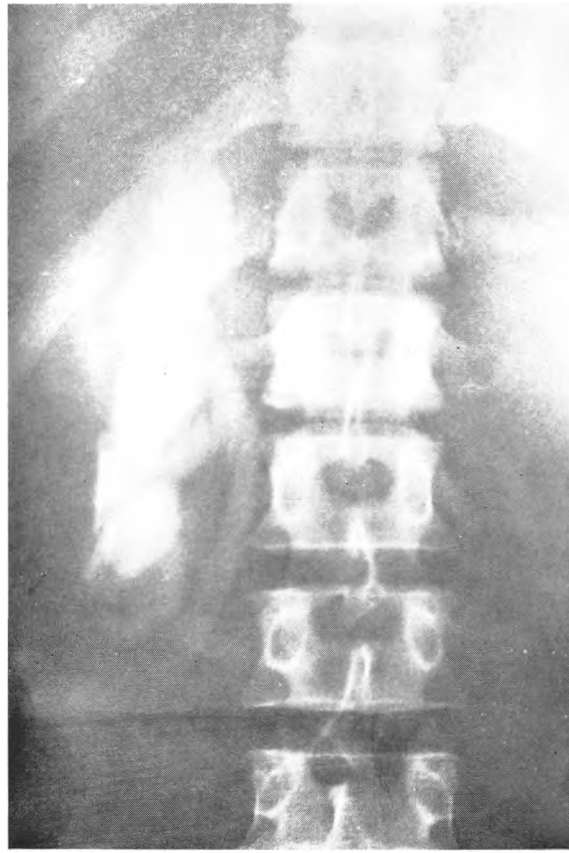

Fig. 20. Urogram of patient with terminal uraemia from obstructive renal disease due to urinary schistosomiasis shows restoration of good function in the right kidney following nephrostomy.

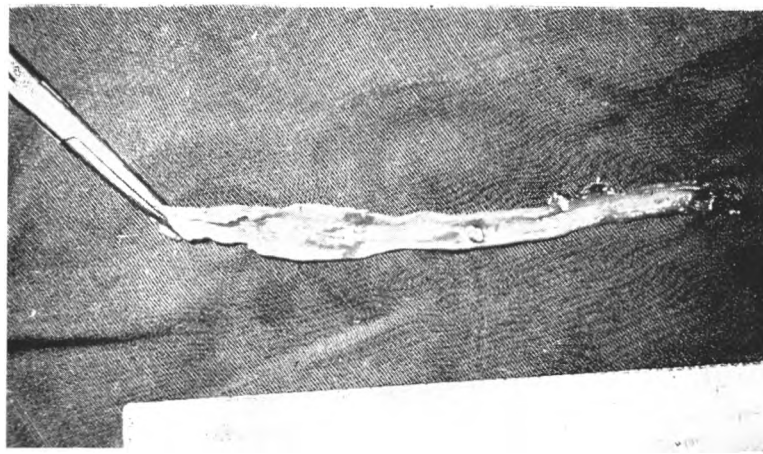

Fig. 21. Resected portion of right ureter in the same patient showing bilharzial stricture and small calculus.

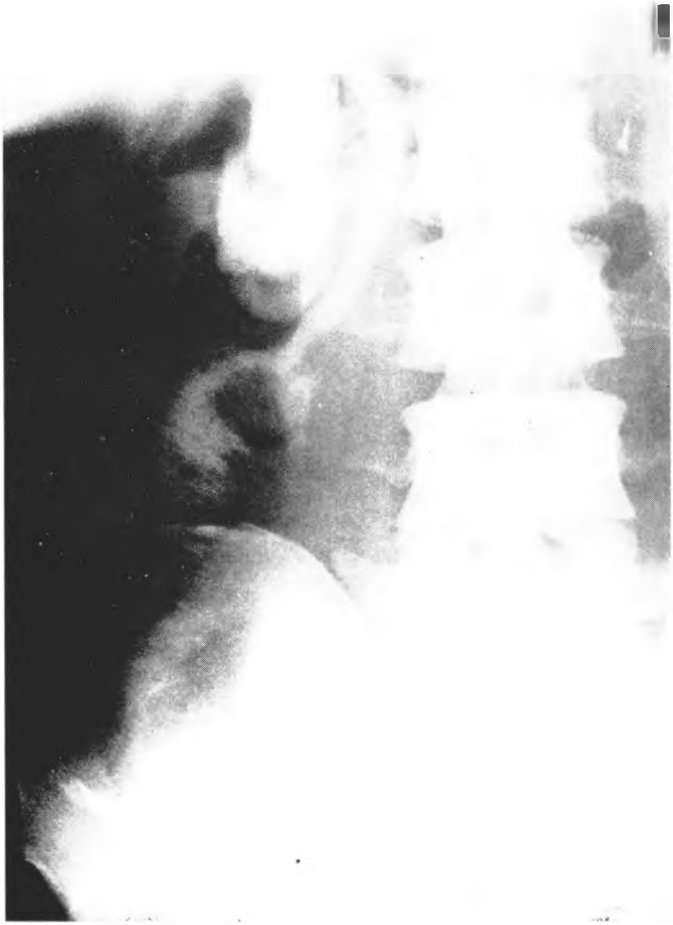

Fig. 22. Urogram showing restoration of urine flow from right kidney to bladder using an isoperistaltic loop of ileum.

Fig. 23. Application of molluscicide to main irrigation supply canal of a sugar estate, using a simple constant-flow device.

Fig. 24. Spraying reed-beds with molluscicide using concentrate diluted by a small petrol-driven proportionating pump.

Fig. 25. Use of stirrup pump to apply molluscicide for local control of snails.

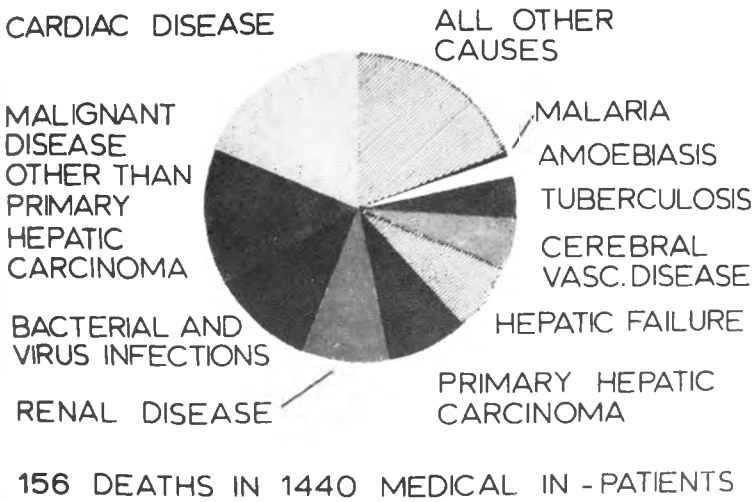
CARDIAC DISEASE
ALL OTHER CAUSES
MALIGNANT DISEASE OTHER THAN PRIMARY HEPATIC CARCINOMA
MALARIA
AMOEBIASIS
TUBERCULOSIS
CEREBRAL VASC. DISEASE
HEPATIC FAILURE
BACTERIAL AND VIRUS INFECTIONS
RENAL DISEASE
PRIMARY HEPATIC CARCINOMA
156 DEATHS IN 1440 MEDICAL IN-PATIENTS

Fig. 26.

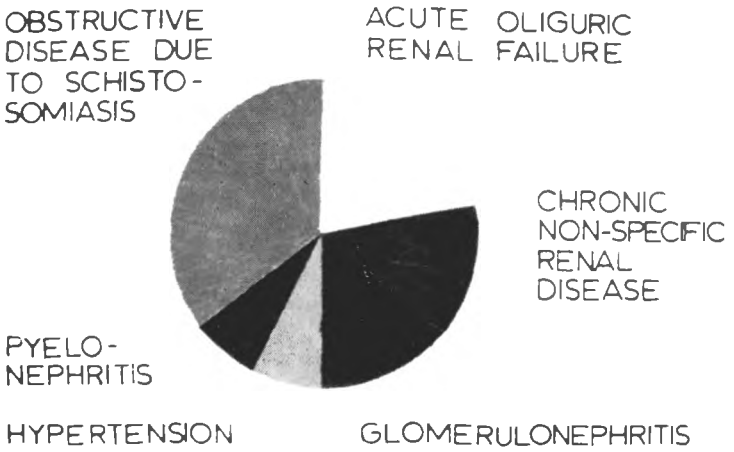
OBSTRUCTIVE DISEASE DUE TO SCHISTO-SOMIASIS
ACUTE OLIGURIC RENAL FAILURE
CHRONIC NON-SPECIFIC RENAL DISEASE
PYELO-NEPHRITIS
HYPERTENSION
GLOMERULONEPHRITIS
14 DEATHS IN 71 CASES OF RENAL DISEASE

Fig. 27.