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A BACTERIOLOGICAL SURVEY OF URINARY TRACT INFECTION IN A MEDICAL UNIT

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ACUTE or chronic infection of the urinary tract is one of the commonest problems in hospital and general practice. Its diagnosis has been the subject of numerous publications and many methods of investigation have been advocated.

The purpose of this paper is to give our findings in a large series of hospital admissions and to record our impressions of the prevalence, symptomatology, investigation and treatment of the disorder.

Material and Methods:

During an arbitrary 2 year period from 1st October, 1964 to the 30th September, 1966, a total of 2,206 patients was admitted to the Medical Professorial Unit of St. Finbarr's Hospital, Cork. On admission, all patients had a mid-stream specimen of urine collected and examined as detailed below. They were also specifically questioned regarding the presence or absence of urinary symptoms.

Three methods were employed to diagnose urinary tract infection in each of the 2,206 patients, namely a quantitative bacterial count, a direct examination of a centrifuged deposit of urine for pus cells, red blood cells and organisms; and the Triphenyl Tetrazolium Chloride Test (T.T.C.). Only those with a positive bacterial count and at least one of the two other criteria were considered to have a urinary tract infection.

All the urine samples were collected by a standard technique. In males, the glans penis was cleaned with a 1/1000 solution of Benzalkonium Chloride (Roccal), some urine voided and mid-stream urine collected into a sterile screw-capped honey jar. Females were prepared as for catheterisation, the initial urine voided and the mid-stream specimen again collected directly into a jar. These jars were brought to the laboratory and a "T.T.C. Test" and Bacterial Count were done on arrival. If immediate examination was not possible, the specimens were refrigerated until they were examined.

Centifruged Deposits:

The urine was spun for five minutes at 3,000 r.p.m. in sterile $3 \times \frac{1}{2}''$ tubes. Ten high power field examinations were made of the deposit. The following arbitrary definitions of pyuria were adopted:—

5–10	pus cells	per	H.P.F.	were	reported	as	pus cells	a few.
10–20	,,	,,	,,	,,	,,	,,	,,	pus +
20–30	,,	,,	,,	,,	,,	,,	,,	pus ++
30 and over	,,	,,	,,	,,	,,	,,	,,	pus +++.

"The Standard Loop Technique" was employed to assess the bacterial count using a sterilised nickel loop (25 gauge, 3 millimetre) in uncentrifuged urine and using a precise plating technique on to Nutrient Agar. After incubation overnight, a colony count was made using a hand lens if necessary. It is assumed that with this technique, a colony count of 200 approximates to the critical figure of 100,000 organisms per ml., and indicates infection (Kass 1956).

The Triphenyl Tetrazolium Chloride or "T.T.C. Test" was carried out as described by Simmons and Williams (1962). When a urinary infection

was diagnosed on the basis of the above criteria, the offending organism was tested against various antibiotics using a " paper disc " technique. Each day every antibiotic in use was similarly tested for its sensitivity to the " Oxford Staphylococcus ". A corresponding sized zone of inhibition was expected with each antibiotic deemed " sensitive ".

Routine sensitivities were done to Streptomycin, Albamycin T, Nalidixic Acid (Negram) and Oxytetracycline. If further sensitivities were required, Kannamycin, Colistin, Nitrofurantoin, Ampicillin or Sulphonamides were similarly tested.

Each patient was given a 10-day course of therapy with a drug to which the organism was sensitive. Three days after completion of the antibiotic course, the urine was again examined as outlined above. A patient was regarded as " cured " only if a bacterial count after this interval resulted in no growth. A negative T.T.C. Test was not considered sufficiently strong evidence of a " cure ". No claim is made that this represents a permanent clinical cure, but only a bacteriological assessment.

If the organism was still present and still sensitive to the original therapy, the course was repeated. If the organism or its sensitiviy had altered, the therapy was changed accordingly and the regime again repeated.

Results

Of the 2,206 patients examined, 1,353 were females and 853 males. Of these, 116 were found to have urinary tract infection. The age and sex distribution of all the patients and those with urinary tract infection are shown in Table I. It will be seen that urinary tract infection is very much more common in women. In the present series it was present in 7.5% of female admissions, compared to 1.8% of males. No male under 50 years was infected (children under 15 years are not admitted to this unit). In women, urinary tract infection was found at all ages, but was twice as common in those aged over 50 years (9.5%) as in those aged less than 50 years (4.7%).

Of the 15 males who had urinary tract infection, 11 had urinary symptoms. The infection was associated with an enlarged prostate in all of these, while a further male patient was paraplegic and had been repeatedly catheterised. Thus, an easily found predisposing cause for the infection was present in 75% of the men—an obstructive element being by far the commonest finding. In contrast, 59 of the 101 infected women had no symptoms referable to the urinary tract, while in the vast majority of the others symptoms were not complained of and were admitted to only on direct questioning. In the majority of the women no predisposing cause for the infection could be found. Parity which is commonly invoked as a major cause for the increased incidence of U.T.I. in women, did not seem a potent factor, in fact 58 of the women found to be infected were nulliparous. The only constant finding was an increased incidence of infection with increasing age.

Because of the interest of one of us in diabetes mellitus, 232 diabetics were admitted during the two-year period. The incidence of urinary infection in diabetics was not found to be significantly greater than in non-diabetics (Table I). The age and sex pattern of diabetics with urinary intection was not significantly different to that of the rest of the series.

TABLE I

Table showing age and sex incidence of urinary tract infection in non-diabetic and diabetic patients

Age	Sex		U.T.I.		Diabetics		Diabetics with U.T.I.	
	Male	Female	Male	Female	Male	Female	Male	Female
10–19 ..	36	54	0	3	2	9	0	0
20–29 ..	69	155	0	6	6	28	0	1
30–39 ..	95	150	0	7	7	12	0	0
40–49 ..	137	216	0	11	8	18	0	0
50–59 ..	222	288	3	17	8	27	1	4
60–69 ..	202	252	5	35	32	45	0	5
70— ..	92	238	7	22	11	19	0	4
TOTAL ..	853	1,353	15	101	74	158	1	14

Of the 116 infected urines (as judged by bacterial counts) only 14 or 12% showed no pus on direct examination. Twenty-five or 22% of the infected urines had a negative T.T.C. Test.

Coliform organisms alone comprised the most common infecting agent being responsible for 75 of the 116 infections. Proteus organisms were isolated in 9 of the infected urines. The remainder were largely mixed infections of Coliform with either Proteus or Enterococci. Only two infections were attributable to Staphylococcus Albus, Table II).

TABLE II

Pattern of infecting organisms

Organism	Female Patients	Male Patients
Coliforms	66	9
Proteus	8	1
Enterococci	2	1
Pyocyaneus	—	1
Staphylococcus Albus	2	—
Coliforms and Proteus	15	3
Coliforms and Proteus and Enterococci ..	2	—
Coliforms and Enterococci	4	—
Coliforms and Pyocyaneus	2	—
	101	15

The organisms were sensitive to Streptomycin, Albamycin T and Nalidixic Acid in a high proportion of cases but to any of the Tetracycline drugs in less than a quarter (Table III). As peptone free agar was not employed, the sensitivities to Sulphonamides were not considered accurate for comparison studies.

The bacteriological response to 10 days antibiotic treatment is shown in Table III. Because of the high proportion of organisms sensitive to Streptomycin and the ease with which it could be administered twice daily in the hospitalised patient, it was the commonest used antibiotic. It was used in 32 cases and a bacteriological "cure" was obtained in each one.

TABLE III

Table showing sensitivity pattern of 116 *infected urines*

	Number Tested	Number Sensitive	Used Solely	Bacteriological Cure
Streptomycin 10 mcg disc ..	116	102	32	32
Albamycin T (Novobiocin 15 mcg T. Hydrochloride 15 mcg)	116	93	33	25
Nalidixic Acid (30 mcg disc) ..	116	90	11	9
Tetracycline (Various) (25 mcg disc)	116	35	2	2

"Albamycin T" was used in 33 cases and 25 of these were bacteriologically "cured". Nalidixic Acid therapy achieved 9 "cures" in the 11 cases in which it was used.

Discussion

Since Kass in 1956 revived interest in the quantitative bacterial count as a reliable method of diagnosing urinary tract infection, many authors have stressed its value. It is however not very suitable for the investigation of large numbers of patients because it is time consuming and for this reason the T.T.C. test has been advocated for such conditions (Simmons and Williams, 1962; Kincaid-Smith, Bullen *et al.* 1964). In our series, 25 patients or 22% of those with positive bacterial counts had a negative T.T.C. test. A positive T.T.C. test depends on the infecting organisms being gram-negative. Twenty-three of the 25 patients who had negative T.T.C. tests had urinary infection due to gram-negative organisms.

The accuracy of the direct examination of the urinary deposit has, in particular, been criticised and it is of interest to compare it with the T.T.C. test which is more usually recommended as a screening test. Of the 116 infected urines, only 12% showed no pus on direct examination. We feel that the direct examination of the urine, in many ways a simpler and less time-consuming procedure, is, in our hands, a more accurate preliminary method of diagnosing infection than is the T.T.C. test. The T.T.C. test might well be reserved for situations where experienced technicians are not readily available and large numbers of urines need to be examined.

In our series, Coliform organisms alone caused 65% of the infections. Apart from Proteus, the only other infecting agents of importance were mixed ones. In the majority of these, the patients had previously been catheterised or an obvious obstructive lesion was present. Infection with Staphylococcus Aureus and Enterococcus was not found to be important, a finding in direct contrast to that of many other workers. It would seem from the present findings that if there is no history of instrumentation or obvious obstruction, a Coliform infection can be assumed and treatment instituted.

The choice of drug used in the treatment of urinary tract infection in the present series was dictated by the sensitivity findings. Because of the difficulty already mentioned in determining sensitivity to sulphonamides, the latter drugs were not used with the same frequency as they would be in general practice. The drug to which by far the greatest number of

organisms were sensitive was Streptomycin and its efficacy both in producing a bacteriological cure and in preventing a relapse made it seem, other things being equal, the drug of choice of those used in the treatment of urinary tract infection. Both Nalidixic Acid and Albamycin T, however, also gave impressive results in ordinary doses over what would be considered by many, to be a very brief period of treatment, and the numbers of organisms which were sensitive to them represent a high proportion of the total in the series. When the disadvantages and discomfort of daily or twice daily injections of Streptomycin are borne in mind, the findings in the investigation suggest that in domiciliary practice Nalidixic Acid and Albamycin T are among the most convenient, least toxic, and most effective methods of treatment for urinary tract infection.

The overall incidence of urinary tract infection in the series (5%) may seem at first sight unduly high. In fact when the age and sex distribution of the patient is taken into account, it probably lies somewhere nearer than expected in a "healthy" population than that found in hospital in-patients in other series (Brumfitt, Davies and Rosser, 1961; Fry *et al.* 1962; Loudon and Greenhalgh, 1962). This is because the present series comprised recent hospital admissions who had not been subjected to the increased risk of urinary tract infection incurred by a stay in hospital. The figure of 5% of all admissions makes clear, however, the necessity for careful bacteriological examination of the urine in all hospital admissions, irrespective of whether they gave a history of urinary symptoms or not. In fact the high incidence of asymptomatic urinary disease is noteworthy. The findings confirm a very much lower incidence of urinary tract infection in males at all ages, and the fact that, when infection does occur in the male, it is almost invariably in men aged over 50 years and nearly always in those with an obvious obstructive lesion of the urinary tract, or in those who have been catheterised. In women, the striking fact emerging from the study is that urinary tract infection is twice as common in those aged 50 years as it is in younger women. Parity and its late results, vault prolapse and similar disorders affecting the functional integrity of the female urethra have, in the past, been held largely responsible for this, while the sequelae of a urinary tract infection acquired during a previous pregnancy have also been considered to be a contributory factor. The finding in the present series that infection of the urinary tract was not significantly more common in the multiparous women than in nullipara, casts doubt on the validity of both of these suppositions. It is worth noting that a lax perineal floor can be found in elderly nullipara as well as in multiparous women, while it has always seemed unlikely to us that infections possibly acquired many years before, could significantly influence the incidence of urinary tract infection in middle and old age.

The finding that urinary tract infection is no more common in diabetic than in non-diabetic patients has been noted previously (O'Sullivan *et al.* 1961; Huvos 1959) but is in direct conflict with the findings of the majority of investigators (Robbins and Tucker 1944; Kass 1956). There are no theoretical reasons why infection should be more frequent in diabetics (Parla and Marmorston 1941; Schofield and Baker 1956). It is suggested that the increased incidence of urinary tract infection found by many workers may well be due to the study of diabetic patients who

have been previously catheterised or had been hospital in-patients for a considerable period.

A number of investigators have stressed the value of looking for urinary tract infection in all pregnant women, because of its high incidence in pregnancy (Kass 1960 ; Turner 1961 ; Chard and Cole 1963 ; Pinkerton *et al.* 1964; Little 1966). The present investigation suggests that a routine search for infection amongst women aged 50 years and over, whether they have urinary symptoms or not, would be at least as rewarding.

Summary

The incidence of urinary tract infection in 2,206 patients admitted to a medical unit during a 24 month period was found to be 5%. It was much more common in women aged over 50 than in any other group. In men it was found chiefly when an obstructive lesion was present, or when the patient had been catheterised.

Direct examination of the centrifuged urine deposit was found to be a more accurate method of diagnosing infection than the T.T.C. test.

Streptomycin, Albamycin T and Nalidixic Acid were all found to be useful drugs in the therapy of urinary tract infection. A high percentage of bacteriological cures was found with each of them.

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