STUDIES ON

THE INCIDENCE, CLINICAL SYMPTOMS, CLINICOPATHOLOGICAL CHANGES, HISTOPATHOLOGY AND THERAPY OF CLINICAL AND EXPERIMENTAL URINARY TRACT INFECTIONS IN DOGS.

By

Vipul Kumar Sinha

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By

Vijai Kumar Sinha, *B. V. Sc. & A. H.*

Bihar Veterinary College,

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Dr. S.S. Mishra
Ph. D. (U.S.S.R.)
Professor and Chairman
Post Graduate Department of Medicine
Bihar Veterinary College, Patna
Rajendra Agricultural University
Bihar.

PATNA,

Dated, the 15 May, 1975.

This is to certify that the work embodied in this Thesis entitled "STUDIES ON THE INCIDENCE, CLINICAL SYMPTOMS, CLINICOPATHOLOGICAL CHANGES, HISTOPATHOLOGY AND THERAPY OF CLINICAL AND EXPERIMENTAL URINARY TRACT INFECTIONS IN DOGS" is the bonafide work of Shree Vijai Kumar Sinha and was carried out under my guidance and supervision.

15/5/75

(S.S. MISHRA)

C E R T I F I C A T E

Certified that the research work encorporated in this Thesis has not been published in part or in full in any of the journal.

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(Vijai Kumar Sinha)

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C O N T E N T S

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ABBREVIATIONS USED

T.E.C.	Total Erythrocytic Count.
Hb.	Haemoglobin.
P.C.V.	Packed Cell Volume.
T.L.C.	Total Leucocytic Count.
E.S.R.	Erythrocyte Sedimentation Rate.
D.L.C.	Differential Leucocytic Count.
N	Neutrophil.
L	Lymphocyte.
M	Monocyte.
E	Eosinophil.
B	Basophil.
BUN	Blood Urea Nitrogen.
Bid	Twice daily (bis in dies).
R.B.C.	Red Blood Corpuscles.
W.B.C.	White Blood Corpuscles.
I/V	Intravenous.
I/M	Intramuscular.
Sp.Gr.	Specific Gravity.
H.P.F.	High Power Field.

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INTRODUCTION

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Kidney plays one of the most important roles in the physiological functions of the body, and expectedly, the support to the kidney efficiency comes from the proper functioning of the other urinary organs and channels. The internal environment of every cell in the body is maintained largely by the kidney and naturally any malfunction of this organ reflects hazardously on every cell of the body tissues. Utilization of the products of digestion is equally hampered by renal diseases. Because of this profound, complex problem in which the dog with renal disease is placed, to improve the social obligatory role of a dog, care ought to be taken on this aspect. It is well-known that the stress on the kidney of a carnivore is comparatively more due to their food habits as compared to herbivores.

Among the various diseases affecting the urinary system, especially, the kidneys and the urinary bladder, are more commonly affected in canine species (Leonard et al., 1953). Evidence of interstitial nephritis has been found in 55 per cent of routine autopsy cases and in 80 per cent of dogs, eight years of age or older at the time of necropsy (Bloom, 1954).

While, obstruction and stasis have been observed

as predisposing factors, pathogenesis of urinary tract infections has been attributed to various micro-organisms most important among them being Escherichia coli and Staphylococci (Wettimuny, 1967 and Mather, 1969). It has been further suggested that the type and quantity of formed elements in the urine also determine the course and prognosis of a disease. The most common among the diseases encountered in the urinary tract infections are cystitis, nephritis, and urethritis. A host of bacteria have been attributed to play the pathogenic role which includes Esch. coli, Staphylococcus sp., Proteus sp., Pseudomonas sp., Klebsiella sp. and Streptococcus sp. (Hogle, 1970). In many cases mixed infection has also been recorded.

With the advent of modern chemotherapy, very expectedly, clinicians took recourse to the usage of various antimicrobial agents for controlling urinary tract infections. Among the antimicrobials used generously on the basis of sensitivity tests are Penicillin, Ampicillin, Chloramphenicol, Tetracycline, Streptomycin, Sulphonamides, and Nitrofuran derivatives.

The pet population in the country and accordingly the number of dog lovers are increasing specially in an urban area like Patna. With the increase in the dog population, the number of canine cases have increased manifold. Among them a significant number of suffering animals has been diagnosed to be cases of urinary tract infection. Keeping in

view the above, in the present study it was envisaged to survey the per cent infection of urinary malfunction cases to identify the micro-organisms responsible for the malady and also to evaluate efficacy of the different antimicrobials. The identification of the microbials responsible for such pathogenesis was thought to be one of the most important parameter in this study since climatic and geographical variations play important role in determining the prevalence of the type of a bacteria in a particular area. Even the biochemical behaviour of a specific bacteria may vary depending on the climatic and geographical situations.

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REVIEW OF LITERATURE

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1. INCIDENCE AND ETIOLOGY.

A. NEPHRITIS :

The occurrence of nephritis in canines had been stated to be one of the commonest cause of death in adult dogs (Wright, 1934).

Bloom (1937) described that interstitial nephritis was by far the most common and important inflammatory renal disease of dog.

Hoskins *et al.* (1953) described bacterial toxins as a cause of acute nephritis in dogs.

Bloom (1954) observed interstitial nephritis in 55 per cent of dogs of all ages on routine autopsy and incidence was more than 80 per cent in older dogs. He also observed that interstitial nephritis was responsible for 89 per cent of all cases of uremia, a common cause of death in old dogs.

Smith (1955) observed that infection due to numerous types of micro-organisms were probably the most important factor causing nephritis, in dogs out of which *Leptospira*, *Esch. coli* and *Streptococci* infection were of clinical importance. He was of the opinion that *Leptospira* infection was probably more prevalent than ordinarily suspected.

Esch. coli infection was often found in the kidney, where it was believed to occur mostly secondary to internal lesions. A close relationship was known to exist between intestinal and kidney diseases. He further pointed out that in disturbed intestinal function the toxic substances were absorbed into the blood stream and micro-organisms causing irritation to the kidneys will create a favourable location for the Esch. coli infections. He was of the opinion that streptococcal infections of the kidney was usually secondary to other foci of infection, particularly the upper respiratory tract. There were strong supportive evidences in favour of focal infections playing an important role in the etiology of kidney diseases, especially in older dogs.

Piermattei (1960) opined that of dogs over 8 years of age, 80 per cent had pathological kidney and in acute urinary tract infections most organisms were Gram-negative and in chronic infections Gram-positive, the type being favoured by pH of the urine.

Pearson (1961) observed the variation in the incidence of acute nephritis of leptospiral origin. He found 25 per cent higher incidence in male than females and many of the nephritis dogs were of younger age group.

Mosier (1963) was of the opinion that infection of the kidney generally started by bacterial invasion of the organ via the blood-stream, and there were usually predisposing

factors as urinary stasis (obstruction) or specific diseased condition, or purulent bronchopneumonia. On bacteriological examination of urine samples, collected from groups of dogs and cats with urinary infection, Proteus sp. (32.1 per cent), Esch. coli (22.6 per cent) and Streptococci (18.9 per cent) was recorded in dogs, whereas in cats Esch. coli (61.5 per cent), Staphylococci (11.5 per cent) and Streptococci (23.1 per cent) were recorded.

B. CYSTITIS :

Krogices (1892) was the first to demonstrate Esch. coli as the cause of urinary tract infection in man.

Morris and Franklin (1939) were of opinion that in canine cystitis the most common bacteria in order of occurrence were Esch. coli, Aerobacter aerogines, Proteus sp.,Staphylococci, Streptococcus faecalis, Salmonella margan and Streptococcus liquifaciens.

Sutherland et al. (1945) diagnosed a case of staphylococcal cystitis in a seven years old dog. The urine was drawn off with a sterile catheter and no urethral obstruction was noted during this process, neither was vesicular calculus palpated on further examinations. Centrifugalisation of urine contained very many leucocytes. On culture Staphylococcus pyogenes albus was isolated from its deposit.

D'Souza et al. (1961) described two cases of coli infection in one year old dogs in which alimentary, respiratory and urinary involvement were evident and Esch. coli was isolated from the faeces and urine sediment.

Mansi (1962) isolated haemolytic Esch. coli (serotype O_{42}) from dogs suffering from nephritis and cystitis. He examined urine from 168 dogs and isolated 64 strains of Esch. coli.

Naidu and Bhatia (1962) reported similar observation in human patients with known or suspected urinary tract infection. Esch. coli was most predominant organism encountered in their investigations with a per cent incidence of 20.8.

Colton (1963) diagnosed a case of acute cystitis in a 4 year old male Schnauzer on the basis of urinalysis and he revealed a heavy growth of Pseudomonas aeruginosa.

Hattangady and Kulkarni (1963) examined 24 canine cases. Bacteriological examination revealed the presence of Proteus sp. in 4 cases.

The organisms most commonly isolated, from canine urinary calculi and urinary infection by Fritsch and Zuylen (1966) were Staphylococcus aureus (18), Proteus vulgaris (6), Pseudomonas aeruginosa (4), Esch. coli (4) and Staphylococcus sp. (9).

Orstadius and Dahlberg (1966) studied 159 dogs

bacteriologically and clinically and observed that 89 had cystitis, 46 urinary calculi and 24 were affected with prostatitis. Out of 159 cases, 59 were infected with Staphylococci, 35 with Esch. coli, 24 with Proteus sp. and 25 with mixed infections. They opined that in 80 per cent of canine urinary calculi cases there was a simultaneous bacterial infection, the majority being Staphylococcus.

Turk (1968) concluded that the patients with chronic bacteriuria who relaps with the same strain, usually had infection in the kidney, whereas in reinfections with new strains, bladder was reported to be more commonly involved.

Mather (1969) isolated hemolytic Streptococci, Staphylococci, Esch. coli, Proteus sp. and Pseudomonas sp. from the cases of cystitis in dogs. Out of 159 affected dogs, 80 per cent had Staphylococci, half of which were in pure culture. He further furnished that in a survey made in University of Minnesota on isolation made from 68 animals with cystitis, the incidence of isolation of micro-organism was for Streptococci (22), Esch. coli (21), Proteus sp.(12), Staphylococci (12), Aerobacter sp. (5) and others (6).

Hogle (1970) examined 141 canine urine samples from clinical cases. He observed 30.5 per cent, 19.9 per cent, 12.1 per cent and 11.3 per cent, infection with Pseudomonas aeruginosa, Proteus sp., Esch. coli and Staphylococcus aureus respectively.

2. SYMPTOMATOLOGY.

In chronic interstitial nephritis, general debility, appearing in later life was observed by Kirk (1939). He described loss of flesh, with intermittent vomiting as the earliest noticed symptoms in nephritis.

Sutherland and Smith (1945) in a 7 year old dog with Staphylococcus cystitis observed that the patient appeared reluctant to move about and prepared to stand with its back arched with hind legs wide apart. Abdominal muscles were very tense and hard on the slightest pressure in this region. The dog evinced pain, rectal temperature was 102°F and the pulse was soft and slow. There was some diarrhoea too.

Hoskins et al. (1953) opined that in most cases of cystitis and urethritis, the animals were depressed, the hair coat was rough and bladder sensitive to abdominal palpation. Occult blood issuing from the urethra, when the animal was not found to be in the act of urinating, was quite likely to be the result of bleeding in the urethra or prostate.

Smith (1955) observed that in acute nephritis, pain accounts for symptoms of stiffness in the hind part, reluctance to move, abdominal arching of back and resistance towards palpation in the kidney region. Many dogs show little or no evidence of pain and the symptoms were largely those of acute

uremia resulting from impared kidney function. Most important symptoms were reported to be observed were inappetance, listlessness, and persistant vomiting. The temperature was found to be normal or elevated in the early stages, and sub-normal in the later course of the disease. Urine secretion was either reduced (oliguria) or suppressed entirely (anuria).

Thirst, polyuria, occasional nocturia and absence of uremia were the essential symptoms of dogs with compensated chronic nephritis (Bloom, 1961).

D'Souza and Raghvan (1961) reported clinical, respiratory, alimentary and urinary involvement in 2 cases of colibacillosis in dogs. Clinical and bacteriological relapses were a constant feature throughout the course. Clinical relapses were generally correlated with the presence of Esch. coli in the urine. Both cases were dull and had dry nose. Temperature ranged from 104°F to 105°F. Pulse - hard, full, regular and bounding. Inability to rise and move freely.

Pearson (1961) observed that dogs with acute nephritis from bacterial or viral cases often showed partial or complete anorexia and depression followed by vomiting and diarrhoea and may have temperature of 104°F to 105°F. In traumatic, toxic and advanced infective cases, the temperature was usually found to be normal or subnormal and the dog might be sensitive in the kidney region. He further described polydipsia frequently occurring in dehydration. In peracute

cases of nephritis, urine flow has been observed to be scanty whereas in subacute or chronic cases polyuria frequently developed. Retained nitrogenous wastes were found to be more commonly present in chronic uremic cases than in acute nephritic cases. He further opined that dehydration and electrolyte imbalance can lead to symptoms of acidosis, fast and shallow respiration, staring eyes, prostration, paralysis of extremities, respiratory paralysis and cardiac errythmia.

Colton (1963) in a 4 year old schnauzer observed (Pyrexia, uremia and vomition) as suggestive of renal damage.

Hattangady and Kulkarni (1963) observed that in cases of hematuria, when the haemorrhage was from bladder, the blood was apt to be abundant towards the end of micturition. They examined 24 canine cases with hematuria of 1 to 10 days duration, out of which 4 were bacteriologically positive for Proteus sp.

Mosier (1963) observed that the symptoms of urinary tract infection in dogs and cats were often vague and physical and laboratory examination only could acurately diagnose such condition.

Kostner (1966) found acute nephritis relatively rare in dogs. Dogs suffering with nephritis showed renal insufficiency, evidenced by loss of appetite, frequent vomition, general weakness, thirst, dullness of the senses, and in some cases uremia.

According to Fish (1966) in a 3 year old female scottie, which was diagnosed as a case of bacterial cystitis, frequent urination and haematuria were observed. On palpation, the bladder was found to be normal.

Blood and Henderson (1968) described that in acute cases of cystitis, there may be moderate abdominal pain and a moderate febrile reaction. They further opined that same syndrome was shown in chronic cases but the abnormalities were less marked. Frequent urination and small volume was the characteristic sign.

Mather (1969) opined that the usual sign of cystitis was frequent urination of small amounts, pain or tenesmus following urination, and abnormal urine.

Osborne (1970) described uremia occurring with renal failure, regardless of the cause of stage (acute or chronic) and may produce weakness, depression, anoraxia, stomatitis, vomition, CNS disturbances.

3. DIAGNOSIS (Clinicopathological and Histopathological changes).

Bloom (1937) described that prevalence of interstitial nephritis was more common in dogs. He further reported that the kidney did not show characteristic changes except in the chronic form. In acute form, the kidneys were found

swollen and the kidney capsule stripped without difficulty. Most striking change was the presence of small pin point or pinhead sized areas which were circular in shape and grayish-white in colour on the surface of the kidney and more particularly in the deeper parts of the cortex. In severe cases the above changes were located in the outer portion of the medulla. These lesions were commonly found in the focal type of the disease but were absent in the diffuse form.

According to Sutherland and Smith (1945) diagnosis of a staphylococcal cystitis in a dog was made by drawn off the urine with a sterile catheter. The urine was found to be alkaline and turbid in appearance. Microscopic examination of the urine revealed to contain very many leucocytes and numerous numbers of staphylococci. No mineral deposits and casts were noted. Sensitive tests were carried on horse blood agar against Penicillin, Sulphathiazol and Sulphapyridin and the Staphylococcus was found to be equally sensitive to Sulphathiazol and Penicillin but not to Sulphapyridin.

Knowles (1959) opined that complete urinalysis gives valuable information about the stage of kidney damage and the information must be shortened to include only specific gravity and microscopic examination. Dogs with chronic nephritis were reported to have an obligatory polyuria and were usually unable to concentrate their urine enough to raise the Sp. Gr. above 1.010 to 1.014. According to him BUN level

upto 20 was considered as normal and over 30 as pathological.

Pearson (1961) emphasized the importance of urinalysis for the diagnosis of acute nephritis.

Bild (1961) held the views that BUN could be expected to go upto 100 to 150 mg per cent in leptospirosis. Degree of kidney damage might be noted by BUN determination. In slight cases where the BUN was 25, the dog would do well with a low protein diet, slight elevation may be found in cases of early dehydration. BUN was within normal range in ailing dogs without the apparent symptoms of dehydration.

Ozier (1963) described that normal Sp. Gr. in dog may range from 1.016 to 1.061 but was reported to be found between 1.025 and 1.040. Sp. Gr. below 1.025 denotes kidney damage, but above that point damage was unlike. He was of the opinion that Sp.Gr. may be lowered in chronic nephritis, diabetes insipidus and when water intake was excessive. It may be raised in case of nephritis, diabetes mellitus and blood loss. The pH was usually acid in carnivorous animals.Acidity was reported to be increased in metabolic acidosis, as in severe diarrhoea, diabetes and chronic nephritis. Alkaline conditions were reported to be found in animals receiving vegetable diet or alkaline drugs, in case of severe vomiting, in proteinuria and in spliting of bacteria of urinary tract.

Phillips (1963) was of the opinion that in acute nephritis the patient had probably been vomiting and generally

showed some degree of dehydration. The hematocrit usually revealed hemoconcentration with increased red cell volume, decreased plasma, and concurrent anemia. Sedimentation rate was reported to be increased in chronic nephritis with anemia.

According to a report from veterinary diagnostic laboratories, New York (1964); proteus culture was obtained from 6 of 10 urine samples, and furadantin was most effective.

Medway (1964) suggested some diagnostic value of urinalysis. Decreased urine volume has been observed in low fluid intake, loss of vomiting or diarrhoea, fever, whereas increased urine volume was due to increased intake of fluid or salt, diabetes, chronic nephritis or pyometra. Blood appearing in beginning of flow had an urethral origin, terminal blood meant cystitis, cloudiness in fresh urine may be caused by bacteria, pus, mucous, blood, crystals in genito-urinary tract. Alkaline urine was reported to be produced by vegetable diet, cystitis or stasis. Sp. Gr. was high in diabetes mel itus, dehydration, fever, acute nephritis whereas dilution was recorded in chronic interstitial nephritis, diabetes insipidus.

McDonald (1964) was of the view that albuminuria was usually more pronounced during the flareups of acute nephritis.

Hoe and O'Shea (1965) reported that with few exceptions rise in blood urea paralleled the degree of kidney damage. Creatinine also appeared to increase in nephritis but

was less reliable than urea determination. Casts appeared only in presence of kidney damage, urinary Sp. Gr. less than 1.010 was found to be frequent in nephritis, but also occurred in other conditions and even in normal dogs. They emphasised the need of careful interpretation in such cases. They were of the view that estimation of serum urea, determination of casts, protein in the urine and repeated urine Sp. Gr. estimations provide the best diagnostic combination and should give upto 90 per cent forecast of all degrees of kidney damage.

Fish (1966) reported a case of bacterial cystitis in a 3 year old female scottie in which BUN and other urine findings were normal. Urine pH was 8 and numerous rbc's, pus cells, and bacteria were present.

Fritsch and Zuylene (1966) observed that in Staphylococcus sp. infection the urine was bloody and turbid whereas in Pseudomonas sp. infection, flaky and yellow.

Nagarajan and Ganapathy (1966) reported highest BUN level of 96 mg per cent at 136 hours and 200 mg per cent at 144 hours. Greatly increased sedimentation rate was one of most significant hematological findings, at 96 hours it increased from 1 mm/hour to 50 mm/hour in one day and to 60 mm/hour in the other. Haemoglobin and RBC's values were only slightly depressed. Leucocytosis was present from 48 hours until death.

Orstadius and Dahlberg (1966) reported that most organisms isolated with urinary tract infection were sensitive

to Neomycin, Nitrofurantoin and Ampicillin.

Zontine (1966) recorded a case of renal inflammation in a German shepherd bitch in which blood and urine examinations indicated the followings, W.B.C. count was 12,800 with segs. 54%, Lymphocyte 28%, Monocytes 2%, Eosinophil 16%. Urine was dark yellow, clear, pH 7, Sp. Gr. 1.020, protein ++, sugar, bilirubin, indicans 0, R.B.C. ++++.

Morgan and Ellington (1967) have placed emphasis on detection of casts, erythrocytes, leukocytes and bacteria in urine in diagnosis of urinary tract diseases.

Clinical diagnosis in 119 nephritis dogs were confirmed on the basis of biochemical criteria by Richard(1967). Of the 119 dogs, 53 had permanent elevated BUN values, in 12 levels decreased to less than 100 mg but were greater than 40 mg per 100 ml, and in 26 dogs, decreased to normal levels.

According to Hogle (1970) culture and disc sensitivity testing of 141 urine clinical samples revealed the presence of different Gram-positive and Gram-negative organisms which were sensitive to Neomycin, Erythromycin, Nitrofurazone, Tetracycline and Dihydrostreptomycin.

CHEMOTHERAPY.

Uvarao (1956) recommended the following antibiotics in the urinary tract infections.

(1) Penicillin :

Its rapid absorption and renal excretion after parenteral administration was well established in most species. About 20 per cent of the dose was reported to be excreted by the glomeruli and about 80 per cent by the tubules.

(2) Streptomycin :

The drug is most active in alkaline urine.

(3) Tetracyclines :

Tetracyclines are excreted through urine at fairly high concentrations; and are more active in acid than alkaline urine. Several pathogenic Gram-positive and Gram-negative organisms responsible for renal infections are sensitive to the drug.

CHLORAMPHENICOL.

Some cases of canine nephritis were reported to respond well but cases of cystitis due to Proteus sp.infection,

which were sensitive to both Streptomycin and Chloramphenicol responded less to the latter.

Mosier and Coles (1958) treated naturally infected cases with various organisms including Streptococci, Staphylococci, Esch. coli, Pseudomonas aeruginosa, Proteus valgaris etc. with furadantin.

Coles and Mosier (1959) experimentally produced the disease by introducing pathogenic organisms including Proteus sp., Pseudomonas aeruginosa and Esch. coli into the kidney and subsequently treated the cases with Furadantin. Doses employed by them were 4 mgms per kg of body weight. Complete recovery in all the cases was reported.

Hattangady and Kulkarni (1963) examined 24 canine with hematuria of (1-10 days duration). Bacteriological examination revealed the presence of Proteus sp. in 4 of the cases. For treatment they divided the animals in 3 groups.

Group I - consisted of 6 animals was treated with nitrofurantoin (furadantin) at the rate of 5 mgms per kg body weight in 3 equal daily doses for 4-6 days and the animals were completely cured.

Group II - consisted of 12 animals treated with Sulpha-phenazol (Orisul Ciba) at a rate of 0.5 gm twice daily for 6 days. All the animals got completely cured except one which was passing clots of blood after urination and subsequently treated with furadantin for more than 6 days for

complete recovery.

Group III - 6 animals were treated with Streptopenicillin in doses of 0.5 gm I/M daily for 4 days. Two dogs in this group recovered. Both furadantin and orisul were 100% effective in clearing up urinary infections whereas Streptomycin-Penicillin combination was only 30% effective.

Bloom (1961) suggested that dogs with uremia whether mild or severe, acute or chronic should be treated by (1) withholding all food and medicines orally. (2) Parenteral administration of water and electrolytes and (3) Injectable vitamins preparations (4) Dextrose saline or dextrose alone.

D'Souza and Raghvan (1961) reported Collibacillosis in two dogs. Esch. coli was isolated from faeces and urine in both animals and clinical and bacteriological relapses were a constant feature. Clinical relapses were generally co related with the presence of Esch. coli in the urine. The disease prolonged for 3 months with little or no response to the several antibiotics. A vaccine prepared from the isolatedstrains of Esch. coli was also ineffective. It was treated with Synarmycin (Pfizer) for a period of one week in the dose of 250 mgs 3 times a day for 3 days, twice a day for 2 days, and once a day for 2 days and follow-up this treatment both patient made steady recovery. Temperature dropped to normal and faeces and urine were found to be negative for Esch. coli. Supportive therapy in the form of multivitamins, glucose, nourishing food

and careful nurs ing helped the patients to hold out.

Colton (1963) had treated a case of cystitis in a 4 year old male dog with Colistin methanesulphonate (Colymycin). Treatment for 16 days consisting of combination of Penicillin and Dihydro-streptomycin, Cosa-terramycin (Pfizer) and Chloromycetin (Park Davis), along with parenteral fluid. No improvement was noted and at the end of this period heavy growth of Pseudomonas aeruginosa was revealed, which was sensitive to Colymycin and Polymixin B. Colymycin therapy (1.1 mg/lb/day I/M) was started and there was immediate improvement. Three weeks later the urine still contained Pseudomonas sp., so in addition to the Colymycin, the animal was given 2400 unit Polymixin twice a day, instilled into the bladder, three days later the urine culture was negative, Colymycin was discontinued and Polymixin was continued for a total of 1 month. Urine culture was negative and the dog was asymptomatic.

Some observation on the efficacy of a group of antibiotics against Esch. coli and Klebsiella aerogenes from urinary infection in human was done by Naidu and Bhatia(1962). On the whole strains of Esch. coli were most sensitive than those of Klebsiella aerogenes to Streptomycin,Chloramphenicol, Terramycin, Aureomycin and Polymixin. Out of these they found Streptomycin to be most effective to both these species,where Polymixin, which was 2nd inorder of sensitivity to Klebsiella

aerogenes, proved to be the least effective against Esch. coli.

According to Andersen (1964) forty humen patients with urinary tract infection due to Gram-negative organisms were treated with Ampicillin orally (0.5 to 0.75 cm every 6 hours) for a period of 2 weeks. In 25 patients the original pathogens was eliminated from urine during treatment. In 6, the original bacteria persisted and in 9 the initial organism was replaced by another species, 11 remained free of infection for atleast a month.

Fish (1966) treated a case of bacterial cystitis in 3 year old female scottie with Tetracycline for 5 days along with Sulphadimethoxine for 14 days, resulting in apparent recovery. The dog returned in 5 months with cystic calculi. This case was typical of those which required more extensive antibiotic therapy, specially in older dogs.

Orstadius and Dahlberg (1966) observed that Tetracycline, Sulphonamides and Penicillin were not effective therapeutic agents for most infecting bacteria, although Chloramphenicol was effective in streptococci and some Proteus infections. Most organisms involved were sensitive to Neomycin, Nitrofurantoin and Ampicillin.

Mather (1969) determined the following doses of antibacterial agents for the treatment of cystitis : -

Organisms	Treatment	Doses
Esch. coli	Nitrofurantoin.	2 mg/lb (0.45 kg) orally every 8 hourly.
	Ampicillin.	5 mg/lb (0.45 kg) oral, I/M or I/V every 6 hourly.
Proteus sp.	Ampicillin.	5 mg/lb (0.45 kg) orally, I/M or I/V every 6 hourly.
	Chloramphenicol.	10-25 mg/lb (0.45 kg) orally every 6 hourly.

Gentamicin, Polymixin, Chloramphenicol and Nitrofurantoin were most effective against Pseudomonas sp. Procainpenicillin G and Tetracycline were used in streptococcal and staphylococcal infections. He has further advocated that if a product has been selected it should be given in the recommended doses and repeated at the proper intervals for atleast two weeks.

Srinivas et al. (1970) observed that Polymixin B sulphate had appreciable antibacterial activity against Pseudomonas aeruginosa isolated from human urine. They did not report any resistant strains against this antibiotic.

Berkman et al. (1971) observed that Gentamicin proved 90% or more effective in the treatment of canine and feline urinary tract infections. Gentamicin in a 50 mg/ml concentration I/M or S/C at 2 mg/lb b.i.d. the first day and then daily for about 7 days gave good to excellent result in 68 of 70 dogs with cystitis, Pyelonephritis or both.

MATERIALS AND METHODS

MATERIALS AND METHODS

1. ANIMALS.

Out of 784 dogs brought for the treatment between December 1973 to November 1974 at Bihar Veterinary College Hospital, against various diseases, 69 cases suspected for urinary tract infections as evidenced by the history and clinical symptoms were picked up for this study.

Besides, six dogs in apparently healthy condition were taken as control. They were from one year to nine years of age group and were kept on similar diet as given to the ailing dogs under investigation.

2. PARAMETERS OF EXAMINATIONS.

1. History (previous and present).
2. General condition (excellent, good, poor).
3. Posture (normal, abnormal).
4. Skin and haircoat.
5. Body temperature and pulse.
6. Visible mucous membrane (conjunctiva).
7. Palpation (kidneys and abdomen).
8. Urine (colour, frequency and quantity of urine (voided).

3. MATERIALS COLLECTED.

URINE :

(a) TIME OF COLLECTION :

The urine samples were collected in morning and the time varied between 8.30 A.M. to 10.30 A.M. Total 75 urine samples including six control were collected. Urine was collected in two sterilized test tube, one for bacteriological and other for pathological examination.

(b) METHOD OF COLLECTION :

After cleaning twice the periurethral area (top of penis in case of male and labial folds, vulva in female) with soap water. The specimen was collected in a test tube sterilized at 160°C for an hour, with a sterilized gum elastic catheter (No. 3,4 and 5) and metalic catheter of different sizes used for dogs and bitches respectively. From each case about 15 ml of urine was collected and immediately brought to the laboratory for further investigation. Samples were processed within one to two hours of collection.

(c) LABORATORY INVESTIGATIONS :

(i) PHYSICAL EXAMINATION:

Urine samples were studied for colour, transparency, specific gravity and their interpretations were made according

to Benjamin (1970).

(ii) CHEMICAL EXAMINATION :

Reaction (pH) : The pH was determined with indicator paper (B.D.H.). The paper was dipped into the urine and after a minute, change in colour was compared with the colour chart provided.

Qualitative estimation : Qualitative estimation of Protein (Albumen), Glucose, Acetone, Bile, and Blood was done according to method described by Benjamin (1970), Boddie (1969).

(iii) MICROSCOPIC EXAMINATION OF URINE :

Tests were performed according to Benjamin (1970), Boddie (1969) and Kolmer (1969) urine samples were examined for the presence of (1) Epithelial cells (2) Epithelial casts (3) Erythrocytes (4) Leucocytes or Pus cells (5) Crystals and (6) Bacterial flora.

(iv) CULTURAL EXAMINATION :

ISOLATION : - Culture of 75 urine samples (including 6 control dogs) collected under strictly aseptic condition were done by standard loop technique (Suri and Bhaskaran, 1974). A loopful (4 mm inside diameter) of un-centrifuged thoroughly mixed urine was placed and stricked on MacConkey agar, the differential media for lactose

fermenting organism, and blood agar medium for isolation of other Gram-positive and Gram-negative organisms, under sterile precautions. The plate was kept for half an hour in position and then incubated at 37°C for 18 to 24 hours. The urine samples from each positive cases were cultured, once a week for threeweeks, to ascertain the presence of micro-organisms during treatment.

Isolates from various media were obtained in pure culture by using conventional method of transferring isolates from solid to liquid and from liquid to solid medium and were subjected for detailed study.

The following general and special media were used for different physiological and biochemical studies pertaining to the identification and characterisation of different organisms : -

(1) Eosin - Methylene - Blue - Agar.

(2) Glucose phosphate broth.

(3) Peptone water.

(4) Sugars such as Glucose, Lactose, Sucrose, Maltose, Mannitol, Arabinose, Dulcitol, Sorbitol (used for carbohydrate studies).

(5) Simmon's citrate.

(6) Christensen's urea medium.

For identification of different organisms, the detailed plan of schedule was described by Cowan and Steel

(1970) was followed.

The following primary and secondary tests were carried out during the course of identification and characterisation of various organisms isolated under this study: -

A. PRIMARY TESTS.

1. Morphology and staining characters :

Shape, arrangement and staining character were studied by using Gram's method.

2. Motility :

Broth cultures of 18 hours growth were examined microscopically in "hanging drop" preparations.

3. Catalase activity :

A loopful of the culture from the nutrient agar medium was transferred on a clean glass slide and a drop of 3 per cent H_2O_2 was added over it. Emergence of gas bubble indicated a positive reaction.

4. Oxidase activity : (Kovack, 1956)

On a piece of filter paper in a petri dish, 2 to 3 drops of freshly prepared oxidase reagent (1% Tetramethyl-p-phenylene diamine dihydrochloride aq.solution) was placed. A loopful of culture from solid medium

was smeared on this impregnated paper. Appearance of dark purple colour on the smear line within 10 seconds indicated a positive result.

5. Carbohydrate studies :

Different peptone water sugars (vide Supra) were inoculated with the cultures and incubated at 37°C. Tubes were examined daily upto 7 days for acid or acid and gas production. Gas production was observed in the previously inverted Durham's tube.

B. SECONDARY TESTS.

1. Citrate utilisation :

Slant of Simmon's citrate was inoculated with single streak of culture and was examined upto 7 days for growth and colour change when a change in colour from original green to blue and growth on streak line indicated a positive result.

2. Coagulase test : (Giellespie, 1943)

0.1 ml of a 18 to 24 hours broth culture was added to a tube containing 0.5 ml. 1/10 dilution of rabbit plasma in saline. The tube was incubated at 37°C followed by examination after 1, 3 and 6 hours for a coagulum. Negative tubes were left at room temperature

overnight and then re-examined.

3. Hydrogen sulphide production :

Organisms were grown in nutrient browth and a lead acetate paper was inserted between the cotton plug and the tube. Tubes were examined upto 7 days for blackening of the inserted paper, indicating H_2S production.

4. Indol production :

One ml. xylol was added to a 48 hours peptone water culture and shaken well. 0.5 ml Ehrlich's reagent was run through the side of the tubes. A pink or red colour at the junction of two fluids indicated the presence of indol.

5. M.R. (Methyl red) and V.P. (Voges-Proskauer) reaction:

(a) Methyl red :

Two tubes of glucose phosphate broth was inoculated with the culture and incubated at 37°C for 2 days. 2 drops of Methyl-red solution was added, shaken and examined. Red colour indicated a positive result and yellow colour, a negative result. The other tube was further kept for V-P tests.

(b) Voges-Proskauer : (Barritt, 1936)

0.6 ml alpha-naphthol solution and 0.2 ml 40 per

cent KoH aq. solution were added to the tube. After mixing the contents by shaking, the tubes were placed in a slanting position. Examination was followed after 15 minutes and 1 hour. A positive reaction was indicated by a strong red colour.

6. Urease activity :

Slants of Christensen's urea medium were heavily inoculated with the cultures and incubated at 37°C. Tubes were examined daily upto 5 days. Presence of purple pink colour indicated that the organism was able to hydrolyze urea. Negative tubes did not show any change in the normal colour of the medium.

Organisms were identified according to Cowan and Steel (1970) and Cruickshank (1970).

5. PATHOGENICITY TEST.

Pathogenicity was carried out with culture of Esch. coli isolated from dogs suffering with urinary tract infection. From a 18 hours broth culture 1.0 ml and 2.5 ml were infected intraperitonially into mice. Two animals were used for each dose and additional two were used as controls which received similar amount of broth only. The experimental animals were observed till 48 hours. The cultures from heart blood, lungs, liver, spleen and kidney of the dead animals were prepared to recover the inoculated organisms.

6. SENSITIVITY TEST.

The following antibacterial drugs were used for the sensitivity tests of organisms isolated from positive cases of urinary tract infection in dogs. The discs were obtained from M/s. Bharat Laboratories, Thana and their concentration per discs are given below : -

Sl. no.	Antibacterial substances used in sensitivity test	Concentration per disc.	Solvent
1.	Ampicillin	10 mcg	Water.
2.	Chloramphenicol	30 mcg	Water.
3.	Furadantoin	100 mcg	Acetone
4.	Penicillin	10 units	Water.
5.	Terramycin	30 mcg	Water.
6.	Kanamycin	30 mcg	Water.
7.	Streptomycin	10 mcg	Water.

The sensitivity test was done by disc method as described by Cruickshank (1970). Zone of inhibition (15 mm or more) was considered as sensitivity of the organisms to the particular antibiotics.

7. HAEMATOLOGICAL STUDIES AND BLOOD UREA NITROGEN ESTIMATION.

(a) Time of blood collection :

Blood samples were collected in the morning when

the animals were brought to the clinic and the time varried between 8.30 to 10.30 A.M.

(b) Method of collection :

3 ml of blood in one test tube cntaining anticoagulant (Heller and Paul*, 1934) and 2 ml in another test tube containing anticoagulant (Potassium oxalate exactly 4 mg) from external saphenous vein from each case was collected. After collection it was mixed gently and was examined invariably within two hours of the collection of blood.

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*Heller and Paul anticoagulant formula.

Potassium oxalate - 0.8 gm

Ammonium oxalate - 1.2 gm

The above chemicals were dissolved in the quantity mentioned against them in 100 ml of distilled water and dispensed into small vials at the rate of 0.1 ml for each 1.0 ml of blood. Anticoagulant was evaporated to dryness in an hot air oven at 60°C. Haematological studies included -

(i) Total erythrocytic count (T.E.C.)

(ii) Total leucocytic count (T.L.C.)

(iii) Packed cell volume (P.C.V.)

(iv) Erythrocytic sedimentation rate (E.S.R.)

(v) Differential leucocytic count (D.L.C.)

and (vi) Estimation of haemoglobin.

E.S.R. was determined by Westergen method and the reading was noted at the end of one hour. For determination of haematocrit (P.C.V.) value, wintrobe haematocrit method was followed and plasma colour noted all the time. For D.L.C. either Leishman stain or Penoptic stain (a combination of Leishman and Giemsa) was used. The standard technique described in the textbooks for both type of staining was followed. Haemoglobin was estimated by Sahlis method.

(c) Estimation of blood urea nitrogen :

Estimation of blood urea nitrogen was done by colorimetric method discribed in instruction leaflet supplied along with blood urea nitrogen kit, by M/s. Bharat Laboratories, Thana.

Reagents used :

Sol. A. - Sulphuric acid solution.
Sol. B. Sodium tungstate solution.
Sol. C. Sodium acetate buffer.
Sol. D. Urea nitrogen standard stock solution containing 1.5 mgms of urea nitrogen per 5 ml.

From the stock standard, working standard solution was prepared by diluting 5 ml to 100 ml with distilled water. 5 ml of working urea nitrogen standard contained 0.075 mg urea nitrogen.

Sol. E. Nessler's solution

Urease powder.

Procedure :

Step 1 : In a clean test tube 7 ml of distilled water and 1.0 ml of solution A was taken.

Step 2 : 1 ml of blood was added after shaking the tube well.

Step 3 : 1 ml of solution B was added.

Step 4 : It was mixed well and kept for 5 minutes and filtered.

Step 5 : Three test tubes graduated at 25 ml and each marked as S (standard), T (test) and B (reagent blank) were taken.

Step 6 : To the tube marked "S" 5 ml of diluted standard solution was taken.
To the tube marked "T" 5 ml of protein free filtrate was added.
To the tube marked "B" 5 ml of distilled water was added.

Step 7 : To each of the three tubes a pinch (about 20 mgms) of urease powder and 0.5 ml of solution C were added.

Step 8 : The tubes were incubated in the water bath at 50°C for 10 minutes.

Step 9 : The tubes urea cooled under running cold water.

Step 10 : To each of the three tubes 10 ml of distilled water and 2.5 ml of solution E were added.

Step 11 : Tubes were diluted to 25 ml mark with distilled water and mixed thoroughly.

Step 12 : Colorimeter reading was taken using blue filter and percentage transmission in each case was recorded by adjusting the water blank to 100 per cent transmission. From percentage transmission, optical density was calculated.

Calculations:

$$\text{mgms of urea nitrogen per 100 ml of blood} = \frac{\text{O.D. of test - O.D. of reagent blank}}{\text{O.D. of standard - O.D. of reagent blank.}} \times 15$$

CHEMOTHERAPY.

Treatment of positive cases for urinary tract infection was done with antibacterial drugs for which the organisms were observed to be sensitive. Total cases were divided into two groups. In group one, the most sensitive drug was given while in group second combined therapy with two of the sensitive drugs was tried.

As supportive therapy ailing dogs were always given

5 per cent glucose saline in the doses of 5 ml per lb body weight I/V or S/C in case of dehydration. Supportive therapy in the form of multivitamins, nourishing food along with symptomatic treatment for vomition, and anaemia were also used.

Chemotherapeutic agents used for the treatment of urinary tract infection in dogs.

Sl. no.	Trade name and firm	Composition and presentation	Dose used	Rate of administration
1.	Ampicillin (Ranbaxy Laboratories, Pvt. Ltd.,New Delhi).	Ampicillin tryhydrate 125 mg capsules.	1 capsule three times a day.	Per os.
2.	Streptomycin - Sulphate (Alembic Chemical Works,Co. Ltd., Baroda-3).	Streptomycin sulphate,vials of 1 g (Injection).	1 G vial daily.	I/M
3.	Kancin Alembic Chemical Works, Co. Ltd., Baroda-3.	Kanamycin sulphate (vials of 0.5 and 1 g) Injection.	1 G vial daily.	I/M
4.	Oxystecline Veterinary(Squibb) Sarabhai Chemical, Baroda.	Oxytetracyclin (B.Vet.C.) vial of 10 ml (50 mg/ml) injection.	2 ml (100 mg) daily.	I/M
5.	Furadantin (Smith Kline & French - Ind.Ltd.,Banglore.	Nitrofurantoin 50 and 100 mg.	1 (100 mg)tab twice daily.	Per os.
6.	Vetycetine Veterinary(Rallis India Ltd.,T.C.F. Division,Bombay).	Chloramphenicol vials of 30 ml (100 mg/ml) injection.	2 ml (200 mg)	I/M

STATISTICAL ANALYSIS.

Data of the present study were subjected to statistical analysis. The following conventional formulae were used :-

$$x^2_{(1)} \text{ (Chi square)} - \frac{N(nd-bc)^2}{(a+b)(b+d)(a+c)(c+d)}$$

$$x^2_{(2)} \text{ (Chi square)} - \sum_{i=1}^{k} \frac{(Oi - Ei)^2}{Ei}$$

Where O = observed value. E = expected value.

$$\text{S.D.} = \sqrt{\frac{x^2}{(n-1)}}$$ Where x^2 = corrected sum of square.

$$\text{S.E.} = \sqrt{\frac{x^2}{n(n-1)}}$$

$$\text{C.V.} = \frac{\text{S.D x 100}}{\text{Mean}}$$

Skeleton of analysis of variance

Source of variation	d.f.	S.S.	M.S.	F
Between groups	G-1	B	$\frac{B}{G-1} = Z$	$\frac{Z}{W}$
Within groups	(N-G)	A-B	$\frac{A-B}{(N-G)} = W$	
Total	N-1	A		

EXPERIMENTAL BACTERIAL NEPHRITIS.

In this experimental studies three healthy, apparently disease free male dogs (No. 11, 12 and 13) of non-descript breed, aged about 2 years and weighing 16, 15 and 18 kg were used. After keeping the dogs under observation for three days, clinical examination, haematological examination, blood urea nitrogen estimation and urinalysis were carried out by the methods which was adopted in the study of clinical cases. The kidney exposure was done by the surgical technique as described by Dhar (1968). In this experiment, however 1 ml of 24 hour broth culture of Pseudomonas aeruginosa isolated from clinical case no. 9 was inoculated in the renal artery of both the kidneys. Feed and water were with-hold for 12 hours after operation so as to put the experimental animals to stress and for the concentration of the urine. An experimental dog was considered infected when the urine was positive for Pseudomonas on cultural test. The clinical symptoms were then recorded and a blood sample was collected from each infected dog for laboratory examinations. Dog No. 13 was retained as an infected control animal and was sacrified on the 6th day. Necessary materials for histopathological study was collected and preserved.

Conventional methods were adopted in processing the tissues and in the preparation of the paraffin sections of 4 to 5 μ thickness. The sections were stained by

Haematoxylin and Eosin (H.E.) to study the general morphological changes. A set of sections were also stained by Grams and Methyline blue for identifying micro-organisms. These standard procedures were adopted according to Culling (1957).

The other two experimental dogs (No. 11 and 12) were treated with Ampicillin and Furadantin to which the organism was sensitive in vitro. 5% glucose, 0.9% sodium-chloride solution, Complex B (Glaxo) and other symptomatic and post-operative treatment were also given.

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OBSERVATIONS AND RESULTS

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1. INCIDENCE AND ETIOLOGY.

In the present study urine samples from 69 canine cases suspected for urinary tract infection on the basis of history and clinical symptoms, were subjected to routine and bacteriological examination for assessing the types of organisms present in them. Out of 69, only 25 animals were positive for bacteriuria and thus the incidence rate of urinary tract infection was recorded as 36.2 per cent.

It has been observed that the incidence rate of urinary tract infection was 50% in the animals of 2 to 4 and 6 to 8 years of age whereas lowest rate (24.1%) has been recorded in animals below 2 years of age as shown below:

Age groups in years	Total no. examined	Total cases positive	
		No.	%
0 - 2	29	7	24.1
2 - 4	12	6	50
4 - 6	10	3	30
6 - 8	18	9	50
Total.	69	25	36.2

Effect of sex as shown below had no significant

difference (statistically) on the incidence rate of urinary tract infection in dogs :

Sex	No. found positive	Per cent	No. found negative	Total
Male	18	40.9	26	44
Female	7	28.0	18	25
Total	25		44	

Seasonal variation was observed to have had highly significant effect ($P > 0.01$) on the incidence of urinary tract infection in dogs as shown below: -

Season	No.found positive	No.found negative	Total
Winter	8	15	23
Summer	6	13	19
Rainy	11	16	27
Total	25	44	69

The percentage of incidence was recorded to be 34.7% in winter, 31.5% in summer and 40.7% in rainy season. The total number of isolates in 25 positive cases were 36, out of which Esch. coli alone was recorded in 13 (36.1 per cent), Proteus vulgaris 6 (16.6 per cent), Staphylococcus

aureus 6 (16.6 per cent), Pseudomonas aeruginosa 7 (19.4 per cent), Klebsiella sp. 2 (5.5 per cent) and Streptococcus faecalis 2 (5.5 per cent) cases (Table 2). Out of 13 isolates of Esch. coli, seven were recorded as mixed infection together with Staphylococcus aureus, Streptococcus faecalis, Proteus vulgaris, Pseudomonas aeruginosa and Klebsiella sp. Percentage incidence of above bacterial infections has been presented in Fig. 1.

2. SYMPTOMATOLOGY.

Clinical symptoms along with their history of all the 25 positive cases of urinary tract infection have been summarised in Table 1.

(a) ACUTE NEPHRITIS:

The common symptoms observed in dogs suffering from acute nephritis were rise of body temperature, anorexia, weakness of hind quarters, pain in the kidney region and vomition. In Bitch No. 364 no abnormal sign was detected on examination, except that it passed dark coloured urine mixed with blood. Dog No. 6 had eczematous patches on the neck and the joint was stiff. Vomition was observed in case No. 9, 62, 84 and 1060. In dog No. 10, the highest temperature was recorded as 105.6°F with pulse rate 120 per minute. Blood in urine was also reported from case no. 62, 10 and 364.

(b) CHRONIC NEPHRITIS :

The bitch suffering from chronic nephritis showed general weakness, poor body condition, dehydration and polyuria.

(c) CYSTITIS :

The most important symptom in dogs suffering from cystitis was rise in body temperature from 102°F to 105°F. Pulse rate recorded was mainly above 100 per minute (full and bounding in some cases) barring a few cases in which it was below 100. In case no. 4 it was as high as 130 per minute. The mean temperature and pulse rate of all cases (positive and control animals) studied in this experiment is given below : -

	Temperature °F per minute.	Pulse rate per minute
Control (6)	100.7 (0.18)	77.16 (3.65)
Acute Nephritis (11)	103.68 (0.37)	105.72 (5.37)
Chronic nephritis (1)	103.0	89.0
Cystitis (12)	103.67 (0.26)	111.92 (4.09)
Urethritis (1)	103.0	110.0

Analysis of variance (Table 3) revealed that there was highly significant ($P > 0.01$) effect on the temperature

and pulse rate of dogs suffering with urinary tract infection.

The common clinical menifestations observed during this study were dullness, depression, partial or complete anorexia, rough hair coat, dehydration, poor general condition and pain in the abdomen on palpation. In case no. 1237 and 235 vomition was also observed. Dog No. 3 and 5 showed st raining at the time of urination. In case No. 1118 blood appeared in the last stream of urine since 4 days prior to the treatment. In case no. 3, 5 and 469 urine contained blood. Weakness of hind quarters accompanied with oedema of hind limb were observed in case no. 3 and 4.

(d) URETHRITIS :

Dog No. 1075 did not show any evidence of pain in kidney or abdominal (bladder) region. It was reported to be dull, depressed, and passed small amount of urine with few drops of blood in beginning of urination.

3. DIAGNOSIS (CLINICOPATHOLOGICAL AND HISTOPATHOLOGICAL CHANGES)

Result of mean values of different urinalysis of control and positive cases of urinary tract infections has been presented in Table 4.

(a) ACUTE NEPHRITIS:

(i) ROUTINE EXAMINATION OF URINE :

Routine examinations of urine were carried out and

the findings have been shown in Table 5. On the day, when the animals were brought to the clinic, routine examination showed high coloured urine in most cases of acute nephritis except in case no. 10, 62 and 364 in which urine was blood tinged. Sp. Gr. and pH were raised from mean normal of 1.020 and 6.75 to 1.028 and 7.27 respectively. Protein was present in all cases. Sugar, bile and acetone remained negative in all the eleven cases. W.B.C. (pus cells) ranging from 1 to 5 to more than 10 per high power field (hpf) and bacteria were recorded in all the eleven cases. Granular, epithelial and tubular cases were also present in all cases except in four dogs (No. 10, 62, 364 and 464). Three cases (No. , 9, 10 and 464) showed presence of erythrocytes, phosphate and urate cystals in urine. Only in one case (No. 464) transitional and in other (No.10) cuboidal epithelial cells were present.

Analysis of variance showed a highly significant ($P > 0.01$) effect in urinary pH. Sp. Gr. though, non-significant statistically, appeared to be showing considerable variation as discussed above and also its 'F' value being close to table value at 5% level (Table 3).

(ii) CULTURAL EXAMINATION OF URINE :

Cultural examination of the urine samples from the eleven bacteriologically positive cases revealed the presence of *Esch. coli*, *Proteus vulgaris*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Streptococcus faecalis*, and *Klebsiella* sp.

(iii) PATHOGENISITY TEST :

Out of five strains of Esch. coli isolated from case no. 1, 6, 10, 216 and 1266, only two strains (from case no. 6 and 10) were non-pathogenic and remaining three strains were pathogenic to laboratory mice (Table 7).

(iv) BLOOD UREA NITROGEN :

BUN showed high value from mean normal of 11.58 to 34.32 in dogs suffering with Nephritis (Table 4). The above finding is confirmed by the analysis of variance (Table 3) showing highly significant effect on urinary tract infections.

(v) HAEMATOLOGICAL EXAMINATIONS :

The mean value of the haematological examination of eleven bacteriologically positive cases has been incorporated in Table 4, when the data's were put to statistical analysis for determining the analysis of variance T.L.C., D.L.C. (N.L.M.E.), Hb%, P.C.V. and E.S.R. values were found to be non-significant. The urinary tract infections in dogs were observed to have significant effect on the values of T.E.C. and BUN, but in case no. 1, 9 and 364 (Table 6) T.L.C. values have been recorded as 35.4, 28.4, and 32.75 thousand per cmm of blood respectively, whereas Neutrophil value in these cases was increased to 68, 82 and 83 per cent respectively.

(vi) HISTOPATHOLOGICAL CHANGES :

Out of two dogs (No. 62 and 84) which died during treatment, the gross and histopathological changes of the kidney of Dog No. 62 was studied. Both the kidney showed mild degree of congestion and no other significant gross lesions were observed. On histopathology, tubular epithelial lining cells of the kidney showed degenerative changes varying from cloudy swelling to complete necrosis (Fig. 4). Desquamated tubular epithelial cells were present in the lumina of the cortex as granular casts. Focal small areas of leucocytic infiltration was observed in the intertubular space of the cortex which were neutrophils and mononuclear cells. Medullary tubules and vascular channels did not reveal any significant changes.

(b) CYSTITIS :

(i) ROUTINE EXAMINATION OF URINE :

Routine examination of urine samples from twelve cases which were diagnosed as cystitis, showed turbidity with the presence of blood in most of the cases. Protein and blood was present in four and three cases respectively. Sugar, Bile and Acetone was absent in all the cases, Pus cells (W.B.C.) and transitional epithelial cells were recovered from twelve and seven cases respectively. Bacteria and erythrocytes were also present in twelve and four cases

respectively. In case No. 464 Ammonium-urates and in case No. 1, 9 and 10, triple and amorphous phosphates was observed.

(ii) CULTURAL EXAMINATION :

Seven strains of Esch. coli, 3 strains of Proteus valgaris, 2 strains of Staphylococcus aureus, 4 strains of Pseudomonas aeruginosa, 1 strain of Streptococcus facalis, and 1 strain of Klebsiella sp. were isolated from twelve cases of cystitis in canines.

(iii) PATHOGENICITY TEST :

Six strains out of the seven strains of Esch. coli isolated in this study were observed to be pathogenic to laboratory mice, whereas one strain (isolated from case No.5) was nonpathogenic (Table 7).

(iv) BLOOD UREA NITROGEN :

There was no significant increase in blood urea nitrogen value in animals suffering with cystitis.

(v) HAEMATOLOGICAL EXAMINATIONS :

The mean value of the haematological examination of twelve bacteriologically positive cases of cystitis has been given in Table 4. On statistical analysis for determining the analysis of variance T.L.C., differential leucocyte count, Hb%, P.C.V. percentage and E.S.R. values were found to be non-

significant, however, T.E.C. and Blood Urea Nitrogen value were highly significant ($P > 0.01$) in the urinary tract infection in dogs, but in few cases of cystitis (case No. 8, 282 and 1005) total leucocyte count was recorded as 31.2, 31.0 and 25.4 thousand per cmm of blood respectively, whereas Neutrophil count in case No. 8 and 1005 was increased to 82, and 75 per cent respectively (Table 6). In case No. 469 T.L.C. value decreased from normal mean value of 17.89 thousand per cmm to 7.8 thousand per cmm of blood.

Overall noticeable changes in D.L.C. was increased Neutrophil count from normal mean value of 69.0 per cent to 72.33 per cent. Lymphocytes, Monocytes and Eosinophils did not show any significant changes.

(c) CHRONIC NEPHRITIS :

Only one (case No. 46) animal was suffering from Chronic Nephritis. Sp. Gr. and pH of urine was recorded as 1.015 and 7.5 respectively. The urine sample was negative for Albumin, Sugar, Acetone, Bile, Erythrocytes, Crystals and Epithelial cells but hyaline cast was recorded (Table 5). Organism recovered from the urine was Esch. coli which was pathogenic to laboratory mice, T.E.C. and Hb per cent was dropped from normal mean value of 7.14 million per cmm and 10 gm per cent respectively. Most significant change observed was increase from normal mean E.S.R. value of 1.58 mm per hour to 10 mm per hour and Blood Urea Nitrogen from 11.58 to

38.0 mgm per cent. There were no significant marked changes observed in differential and total leucocyte count.

(d) URETHRITIS :

Dog no. 1075 was diagnosed to be a case of urethritis. On routine examination of the urine the Sp. Gr. and pH was found to raised from normal mean value of 1.020 and 6.75 respectively to 1.030 to 8.0 respectively. Pus cells, squamous epithelial cells, erythrocytes, and bacteria were recovered from urine but it was negative for Albumen, Bile, Sugar and Acetone (Table 5). Esch. coli was the only pathogenic organism, isolated from the urine of this dog. T.L.C. and Neutrophil Count showed marked increased value (Table 6). Other findings were not significant.

4. CHEMOTHERAPHY :

(a) NEPHRITIS :

Treatment of all the eleven bacteriologically positive cases of Nephritis (acute) carried out with anti-bacterial drugs for which the organisms were observed to be sensitive. Out of the eleven cases of Nephritis, four case (case No. 1, 6, 10 and 216) were of mixed infection (Table 8). Esch. coli was one of the common organism present in association with Staphylococcus aureus, Streptococcus faecalis, Proteus vulgaris, and Klebsiella in all the four cases. Two

cases of mixed infection were treated with combined therapy and two with single drug. In two cases (No. 1 and 6) Kancin was 100% effective as both the animals were asymptomatic and urine was sterile within five days, whereas two other cases which were treated with combined therapy, Kancin and Furadantin (case no. 10), in one case and Oxystecline with Furadantin (case no. 216) in other. Both the animals were cured within five days. Out of the remaining 7 cases, two animals (case No. 62 and 84) positive for Pseudomonas aeruginosa died during treatment. Dog No. 62 was passing blood in urine and frequent vomition was noticed during the period of treatment. It was treated with Furadantin, to which it was sensitive. During the treatment the temperature came down to 100°F on 5th day but the staggering gait and partial anorexia continued to be present till 9th day and ultimately the dog died on 10th day.

Till 4th day of treatment with Furadantin in dog no. 84 though there was some improvement in appetite but the body temperature remained elevated (103°F). Then on 5th day Kanamycin was given without any further improvement in the clinical sign of the disease. On 9th day the animal vomited twice and died in the evening.

Out of remaining 5 cases from which only single organism was recovered, one was treated with the combination of Furadantin and Kanacin and it was cured on 4th day. Dog no. 1266 could not be cured after treatment with Streptomycin for 18 days but when it was put on Kanacin for 8 days complete

recovery was noticed. It was further observed that with the start of Streptomycin therapy temperature came down to 103°F on 3rd day but again it started rising and during the period of treatment relapse in temperature was the common feature and the fever was relapsing in nature. From 18th day the animal was put on Kanacin and gradually temperature started falling and reached 101.5°F on the 26th day (Fig. 2). From 20th day, Digiplex (orally), Inferon and 50 ml Biogludox parenterally were also given as a supportive therapy and the dog became asymptomatic.

Case No. 10 which had the history of hematuria and mixed infection (Stapha aureus and Klebsiella sp.), recovered fully with Kanacin and Furadantin in 5 days. This dog was given 50 ml Bigludox I/V for 3 days with Styptovit 1 tab bid.

Dog No. 364 was treated with Ampicillin for 7 days along with Styptovit 1 tab twice daily from 3rd to 5th day and it recovered completely. Urine became clear and dog was asymptomatic except attempts to vomit after the course of treatment was observed.

Dog no. 1060 was treated with Streptomycin for 10 days, but no marked improvement was noticed. Temperature did not come to normal till 10th day. Hence the treatment was started with Furadantin for 5 days in order to have complete recovery. Multivitamins 1 tab three time a day for 15 days with Margine 1 tab Bid for 2 days was also given. Vomiting stopped within two days.

Dog no. 9 which was treated with combined therapy of Ampicillin and Furadantin took 20 days to recover. Temperature came to normal with improvement in the appetite, after the course of the treatment but occasional vomiting was observed although urine was negative for the presence of any bacteria.

(b) CYSTITIS :

Out of 12 cases of cystitis only 5 (case No. 2,5, 7, 8 and 462) were of mixed infection. Case No. 5 was treated with combined therapy of Furadantin and Ampicillin for 7 days along with 5% Glucose Saline 50 ml I/V daily for 5 days, Multivitamin 1 tab Bid for 7 days, Inferon 2 ml I/M alternate day (3 injection) the animal was cured after treatment.

Dog No. 7 and 469 were treated with Kancin for 10 and 4 days respectively. In former one fever dropped to 102°F on 7th day and appetite returned to normal, but urine was sterile on 10th day, whereas latter was given Styptovit for 2 days and the dog was clinically normal on 4th day.

Dog no. 8 was given combined therapy with Furadantin and Ampicillin for 5 days along with 5% Glucose saline from 3rd day when the fever came to 102°F. On 5th day the animal was active, temperature fell down to 101.5°F but the appetite was not fully restorted.

Dog no. 3 was treated with Furandantin for 10 days along with Styptovit. Temperature though returned to normal

and urine was clear but on bacteriological examination it still contained Esch. coli. From 11th day Furadantin and Styptovit was discontinued and Kancin was started. It was discontinued on 15th day when the urine was sterile.

Dog no. 4 was treated with Vetycetin (Chloramphenicol) to which the organism Esch. coli was sensitive next to Kancin. The temperature did not come normal till fortnight, hence it was stopped and Kancin was started which proved efficacious to control the fever and eliminating the organism from the urinary tract. During the period of treatment salt was prohibited and Glucose solution 5% was injected from 16th day for 4 days.

Dog no. 1005 showed the similar trend of body temperature till it was treated with Vetycetin for 10 days except improvement in appetite. To combat dehydration 5% Glucose saline 50 ml I/V for 5 days along with Digiplex (orally) was also given. From 11th day Kancin was given for 5 days. Urine completely became sterile after the course of Kancin, but general weakness, staggering gait and vomiting developed. From 15th day the dog was kept on Horlicks, Belamyl (Squibb), Glucose solution (Parenterally) and the Margine tab twice a day were administered. From 18 day there was a tremendous improvement but the symptomatic treatment was continued till 20th day.

Case No. 2 was given the combined therapy of

Ampicillin and Furadantin for 4 days. The dog was cured clinically.

Dog no. 118 was dehydrated and anaemic. It was treated with Furadantoin and Ampicillin for 4 days along with Styptovit 1 tab bid, Bigludox 25% 50 ml I/V, Inferon 2 ml I/M alternate day for 6 days. Dog was completely cured and asymptomatic.

Case no. 235 was treated with Furadantin first for 7 days but temperature did not come normal hence Kancin was tried for further 5 days in place of Furadantin, which brought the temperature normal and the dog was asymptomatic.

Dog no. 1237 and 282 could not be cured with Streptomycin which was tried first for 7 days but these two cases were treated successfully with Furadantin in 7 and 5 days respectively. Supportive therapy with Vitamins, and antiemetic drugs were also given.

(c) CHRONIC NEPHRITIS :

Bitch no. 46 which had polyuria with general weakness and poor body condition, was treated with Vetycetin (Chlorampehnicel) for 7 days without any clinical improvement so the animal was put on Kancin for further 8 days to get a complete recovery.

(d) URETHRITIS :

Dog no. 1075, the only case of urethritis was

treated with Ampicillin for 5 days. The animal was not recovered fully. Pain during urination along with drops of blood in urine was observed during the course of treatment. From 6th day Ampicillin was replaced by Kancin and the animal became asymptomatic in 4 days.

EXPERIMENTAL BACTERIAL NEPHRITIS.

The cultural test of the 48 hour urine samples collected from the three dogs (No. 11, 12 and 13) were positive for Pseudomonas aeruginosa. All the three experimental dogs were found to pass bloody urine. Symptoms of retching, nausea, vomition, pain on palpation of kidney region were noticed in all the three animals. The body temperature of all the three animals ranged between 104 - 105.5°F.

Dog no. 13 (infected control) became rapidly dehydrated and weak. Temperature and pulse rate remained increased till 6th day after operation and gradually the condition deteriorated. On 6th day, it was sacrificed and materials were collected for examination.

GROSS CHANGES IN THE KIDNEY :

Focal adherance of the capsule was observed on the site of suppuration at the subcapsular surface of the kidney. The subcapsular surface was also congested and showed white depressed focal areas of about 1 to 2 mm diameter. Cut surfaces showed white radiating streaks which extended from cortex to

pelvis.

HISTOPATHOLOGY OF THE KIDNEY :

Vascular channel of both cortex and medula showed varying degree of engorgement. In general, the cells lining the tubules of both cortex and medulla showed varying degrees of degenerative changes ranging from cloudy swelling to complete necrosis. Some of the desquamated epithelial cells were present in the tubular lamina as granular casts. Multiple focal areas of suppuration were also seen both in the cortex and the medulla which were heavily infiltrated with neutrophils and a few mononuclear cells. Focal accumulation of neutrophils were observed around the Bowman's capsule and intertubular space of the cortex and the medulla. A single focal suppurative lesion was observed extending from the cortex to the medulla. On the base of medullary region, the area of suppuration showed extensive haemorrhage, heavy infiltration of neutrophils and cellular debri s with a very few mononuclear cells. Extensive haemorrhagic areas were also seen around the suppurative lesions. Grams method of staining failed to reveal the presence of micro-organisms whereas when stained with Methylene blue the sections showed the presence of minute rods morphologically indistinguishable from Pseudomonas sp.

Right kidney also revealed similar changes.

The result of the clinical, haematological exami-

nation and urine analysis have been shown in Table 10.

It would be seen from the table that the highest level of BUN (68 mg %) was recorded in Dog No. 13. In all the dogs, there was a decrease in both T.E.C. and Hb% accompanied by Leucocytosis with increase number of Neutrophils count have been observed.

Two dogs (No. 11 and 12) were treated for 18 days with Ampicillin (oral) and Furadantin (oral) along with 0.9% sodium chloride solution at the rate of 50 ml per day I/V for 7 days. Margin was given 1 tab three times a day orally for 5 days. Treatment was initiated 3 days postoperation. Easily digestible diet such as milk, barley were given for the first 5 days. The Ampicillin and Furadantin treatment was continued for 48 hours after two consecutive urine samples were bacteriologically negative. Urine samples were collected twice in a week for 3 weeks.

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TABLE - 1.

Showing details of clinical cases of urinary tract infections in dogs.

Case No. and date	Sex	Breed	Age (year)	History	Clinical signs		
					Temperature °F	Pulse	Other finding
1	2	3	4	5	6	7	8
ACUTE NEPHRITIS							
1 22.12.1973	M	Alsatian.	1	Anorexia, weakness of hind-quarter since 4 days.	104.0	110	Pain in left abdomen on palpation, dried nostril, weakness of both the hind limbs.
1060 19.1.1974	M	-do-	8	Attempt to urinate with very small volume of urine.	102.8	100	Weakness of hindquarter, vomition, occasional coughing, Rt.lungs congested, pain in Rt.kidney.
1266 28.3.1974	F	Non-descript.	8	Unwillingness to move, run-down condition.	105.0	120	Forceful pulse, dull and emaciated, conjunctival m.m. anemic.
62 20.4.74	M	Alsatian.	7	Small volume of urine, hematuria.	103.0	89	Vomited in clinic.
84 27.4.1974	M	-do-	3½	Anorexia since 2 days, diarrhoea since last morning.	104.6	120	Depressed, attempt to vomit as anything lodged in the oesophagus. Resentment on palpation of kidney region.
216 24.6.74	F	-do-	8	Dull, depressed and anorectic.	103.0	94	Staring eyes with anemic conjunctival mm. Weakness of Rt. hindquarter.

TABLE - 1 (Contd.)

1	2	3	4	5	6	7	8
364 19.8.1974	F	Alsatian.	3	Appetite normal, haematuria since two days.	102.0	80	No abnormality detected.
6 28.8.1974	M	-do-	2	Inappetance since 2 days, frequent vomiting after meal and attempt to vomit even in empty stomach, dull and drepressed.	103.4	100 (bounding)	Stiff gait, eczema like patches on the body coat.
464 26.9.1974	F	-do-	3	Depraved appetite since 2 months, vomiting twice daily since 3 days.	104.0	130	Emaciated, general condition poor, conjunctival m.m. angry, abdomen tender kidney - not palpable.
9 6.10.1974	M	Boxer.	6½	Off fed since 4 days, passed scant urine with pain.	104.5	115	Less water intake, vomiting left kidney slightly tense
10 9.11.1974	M	Alsatian.	2½	Partial anorexia, dull, blood in urine. Suffered in August'74 with heavy infection of Esch. coli.	105.6	120	Conjunctival m.m. congested, pain on palpation of left kidney.
				CHRONIC NEPHRITIS			
46 18.4.1974	F	-do-	4½	Partial anorexia, stool hard and urine light colour, polyuria.	101.6	74	General weakness and poor condition, dehydration.
				URETHRITIS			
1075 28.1.1974	M	Non-descript.	7	Dull, depressed, temp. since 5 days, anorexia, polydipsia. Treated with Dicrysticin, Alkacitron and Complex B (Glaxo) since 3 days.	103.0	110	General condition poor, no pain on palpation of kidney or abdominal region.

TABLE - 1 (Contd.)

1	2	3	4	5	6	7	8
				CYSTITIS			
1005 19.12.1973	M	Alsation.	6	Off fed since 4 days, treated with Dicrysticin and Hosta-cyclin .5 gm tab. for 3 days.	104.0	120	Dull and depressed, anorexia, body gcoat rough, conjunctival m.m. congested.
2 16.1.1974	F	-do-	1	In December urine positive for albumin, Esch. coli and Pseudomonas sp., fever since 8 days.	103.4	110	Dull and depressed, conjunctival m.m. anemic, polydipsia.
1118 15.2.1974	M	-do-	6½	Haematuria since 4 days and anorexia.	103.4	110	Conjunctival m.m. anemic, general body condition poor, rough hair coat.
3 22.2.1974	M	-do-	2	Dull, partial loss of appetite, haematuria, frequent urination since 2 days.	104.8	120 (full and regu-lar)	Weakness of porterior quarter, general con-dition poor, shallow breathing with conge-stion of both lungs.
1237 16.3.1974	M	Non-descript.	5	Painfull urination, vomiting from yesterday.	104.0	120 (hard and full)	Pain exhibited on pal-pation of bladder.
235 3.7.1974	M	Lebradar.	4	Anorexia, arched back, occasional vomiting.	103.0	94	Evidence of abdominal pain on palpation.

TABLE - 1 (Contd.)

1	2	3	4	5	6	7	8
282 18.7.1974	M	Lebradar.	6½	Restlessness, pain during micturation, fever since a week.	103.5	120	Urine mixed with pus and turbid, conjunctiva anemic.
4 22.8.1974	F	-do-	2	Fatigued on exercise, polyuria with light colour urine. In October suffered with Esch. coli and Pseudomonas sp.,infection of urine.	105.0	130	Hard and regular, distension of abdomen, weakness of hindquarters, oedema of limb, dehydrated and rough hair coat.
5 23.8.1974	M	Alsation.	1½	Micturition accompanied by circuling movement and dog licking of the peri-urethral portion of penis, haematuria also reported.	102.0	84	Conjunctival m.m. angry.
7 18.9.74	M	-do-	1½	Oliguria, suffered with hookworm and treated with ancylol.	105.0	130 (hard and regu-lar).	Pain while passing catheter.
469 28.9.1974.	M	-do-	7	Temperature 103.4 on 25.9.74, dull, off fed and haematuria.	102.6	100	General condition poor and rough hair coat.
8 5.10.1974	M	-do-	2¼	In August'74 suffered with hookworm, Toxocara canis and treated with Tetracap and Antepar.	103.4	105	Bounding in and full, General condition poor, no pain on palpation of kidney or abdomen.

M = Male. F = Female. m.m. = Mucous membrane.

TABLE - 2.

Table showing result of the antibiotic sensitivity test.

Isolates	Esch. coli	Proteus vulgaris	Staphylococcus aureus	Ps. aeruginosa	Klebsiella sp.	Streptococcus faecalis
Total number.	*13(36.1%)	*6(16.6%)	*6(16.6%)	*7(19.4%)	*2(5.5%)	*2(5.5%)
Kanamycin.	13(100%)	2(33.3%)	6(100%)	2(28.5%)	2(100%)	2(100%)
Chloramphenicol.	6(46.1%)	4(66.6%)	4(66.6%)	2(28.5%)	2(100%)	2(100%)
Ampicillin.	6(46.1%)	2(33.3%)	5(83.3%)	4(57.1%)	2(100%)	2(100%)
Streptomycin.	7(53.8%)	5(83.3%)	4(66.6%)	1(14.2%)	1(50%)	1(50%)
Penicillin.	2(15.3%)	R	2(33.3%)	R	R	2(100%)
Terramycin.	4(30.7%)	3(50%)	2(33.3%)	1(14.2%)	2(100%)	2(100%)
Nitrofurantoin.	10(76.9%)	4(66.6%)	5(83.3%)	6(85.5%)	2(100%)	2(100%)

* In the 25 positive cases of urinary tract infection in dogs.

R indicate resistance (zone of inhibition less than 15 mm).

TABLE - 3.

Showing analysis of variance (F test) of Nephritis and cystitis.

Sl. No.	Variables	Calculated "F" value	Table "F" value	
			5% level	1% level
1.	Temperature	20.89**		
2.	Pulse	11.29**		
3.	T.E.C.	5.92**		
4.	Hb.	0.94 N.S.		
5.	P.C.V.	1.95 N.S.		
6.	E.S.R. mm/hour	2.80 N.S.		
7.	T.L.C.	0.16 N.S.		
8.	D.L.C.		3.37	5.53
	(a) N	0.48 N.S.		
	(b) L	0.32 N.S.		
	(c) M	0.04 N.S.		
	(d) E	0.57 N.S.		
9.	BUN	76.18**		
10.	pH	5.21*		
11.	Sp.Gr.	3.02 N.S.		

** denotes significant at 1% level.

* denotes significant at 5% level.

N.S. denotes Non-significant.

($P > 0.05$)

($P > 0.01$)

TABLE - 4.

Table showing mean values of the different blood cells and blood urea nitrogen.

Description of cases	T.E.C. million/ cmm.	T.L.C. thousand/ cmm.	Hb gms%	P.C.V. %	E.S.R. mm/hour	Differential leucocyte count					BUN mg%
						N %	L %	M %	E %	B %	
Control 6	7.14 (0.41)	17.89 (2.22)	13.97 (0.41)	43.05 (1.78)	1.58 (0.37)	69.00 (1.16)	21.80 (0.73)	6.13 (0.38)	2.93 (0.29)	Nil	11.58 (1.12)
Acute Nephritis cases 11	5.50 (0.27)	19.76 (2.64)	12.46 (0.60)	33.82 (1.96)	4.18 (0.84)	71.09 (2.72)	19.91 (2.48)	6.09 (0.80)	2.91 (0.36)	Nil	34.32 (1.71)
Chronic Nephritis cases 1	4.67	18.60	10.0	28	10	65	21	9	5	Nil	38.00
Cystitis cases 12	5.41 (0.35)	19.89 (1.97)	12.44 (0.96)	34.93 (1.98)	3.08 (0.54)	72.33 (1.60)	19.50 (1.23)	5.75 (1.29)	2.41 (0.41)	Nil	14.55 (1.07)
Urethritis case 1	5.20	26.20	12.60	30.00	3	78	16	4	2	Nil	12.60

(-) ± S.E.

TABLE - 5.

Showing routine urinalysis of bacteriologically positive cases in urinary tract infection in dog.

Case No.	Physical examination			Chemical examination			Microscopic examination					
	Colour	Sp.Gr.	pH	Protein	Sugar/ acetone/ bile	Blood	Pus cell/ H.P.F.	Casts/ H.P.F.	Cells/ H.P.F.	R.B.C./ H.P.F.	Bacteria	Cystals.
1	2	3	4	5	6	7	8	9	10	11	12	13
							ACUTE NEPHRITIS					
1	High coloured.	1.030	6.5	++	-	-	+ more than 10	+ granular, more than 10	-	-	+	Triple phosphate
1060	Dark yellow.	1.035	7.0	+	-	-	+ 1 to 5	+ granular, 1 to 5	-	-	+	-
1266	Pale yellow.	1.015	7.0	+	-	-	+ 1 to 5	+ granular, 1 to 5	-	-	+	-
62	Blood tinged.	1.025	7.5	+++	-	+	+ 1 to 5	-	-	+ more than 10	+	-
84	High coloured.	1.030	8.0	+++	-	-	+ more than 10	+ granular, 5 to 10	-	-	+ few spermatozoa.	-
364	Blood tinged.	1.035	7.5	++	-	+	+ 1 to 5	-	-	+ more than 10	+	-

TABLE - 5 (Contd.)

1	2	3	4	5	6	7	8	9	10	11	12	13
6	High coloured.	1.015	7.0	+	-	-	+ 1 to 5	+ epithelial 5 to 10	-	-	+	-
464	-do-	1.025	7.5	++	-	-	+ 5 to 10	-	+ Transitional epithelial 5 to 10	+ 1 to 5	+	+ amorphous urates.
9	-do-	1.040	7.0	+++	-	-	+ 1 to 5	+ epithelial 5 to 10	-	+ 1 to 5	+	+ triple phosphate.
10	Blood tinged.	1.035	8.0	+	-	+	+ 5 to 10	-	+ epithelial cuboidal 1 to 5	+ more than 10	+	+ amorphous phosphate.
216	Pale yellow.	1.025	7.0	+	-	-	+ 1 to 5	+ tubular 1 to 5	-	-	+	-
							CHRONIC NEPHRITIS					
46	Light yellow.	1.015	6.5	-	-	-	+	+ hyaline 5 to 10	-	-	+	-
							URETHRITIS					
1075	Pale yellow.	1.030	8.0	-	-	-	+ 1 to 5	-	+ squamous epithelial 1 to 5	+	+	-

TABLE - 5 (Contd.)

1	2	3	4	5	6	7	8	9	10	11	12	13
							CYSTITIS					
1005	Dark yellow.	1.020	8.0	-	-	-	+ 5 to 10	-	-	-	+	+ Triple phosphate.
2	Turbid.	1.015	7.5	-	-	-	+ 5 to 10	-	+ transitional epithelial 5 to 10	-	+	-
1118	Blood tinged.	1.015	7.5	+	-	+	+ 1 to 5	-	-	+ more than 10	+	-
3	-do-	1.030	7.5	++	-	+	+ 5 to 10	-	+ transitional epithelial 1 to 5	+ more than 10	+ few spermatozoa.	+ triple phosphate
1237	Turbid.	1.040	8.0	-	-	-	+ more than 10	-	+ transitional epithelial more than 10	-	+	-
235	Pale yellow.	1.025	8.0	-	-	-	+ more than 10	-	+ transitional epithelial 5 to 10	-	+	-
282	Cloudy.	1.020	7.5	++	-	-	+ 5 to 10	-	-	-	+	+ triple phosphate

TABLE - 5 (Contd.)

1	2	3	4	5	6	7	8	9	10	11	12	13
4	Light yellow.	1.025	6.5	-	-	-	+ 1 to 5	-	-	-	+	-
5	Blood tinged.	1.020	8.0	-	-	+	+ 1 to 5	-	+ transitional epithelial 1 to 5.	+ 1 to 5	+	-
7	Cloudy.	1.015	8.0	-	-	-	+ 1 to 5	-	-	-	+	-
469	Blood tinged.	1.020	6.5	+	-	+	+ 1 to 5	-	+ transitional epithelial 1 to 5	+ 5 to 10	+	+ ammonium urate.
8	Turbid.	1.020	7.5	-	-	-	+ 5 to 10	-	+ transitional epithelial 5 to 10	-	+	+ ammrphous phosphate.

TABLE - 6.

Table showing haematological examination and blood urea nitrogen values in urinary tract infection in dog.

(For each parameter only the mean has been shown).

Case No.	T.E.C. million/ cmm.	T.L.C. thousand/ cmm.	Hb gm %	P.C.V. %	E.S.R. mm/ hour	Differential leucocyte count (per cent)					BUN mg %
						N	L	M	E	B	
1	2	3	4	5	6	7	8	9	10	11	12
						ACUTE NEPHRITIS					
1	5.83	35.4	13.2	34	6	68	24	6	2	0	45
1060	4.8	17.8	12.6	32	4	70	22	5	3	0	34
1266	4.42	20.02	9.0	28	9	67	19	8	6	0	30
62	5.99	12.4	12.61	39	8	66	22	10	2	0	23.6
84	5.46	13.0	13.5	38	3	64	26	8	2	0	29.4
364	7.8	32.75	16.0	47.4	0	83	10	5	2	0	34.5
6	5.2	9.4	12.4	31	1	58	36	2	4	0	37.45
464	4.8	15.22	9.0	24	3	76	18	3	3	0	37.5
9	5.96	28.4	12.2	32.6	4	82	10	6	2	0	39.5
10	5.0	20.0	13.6	28	2	85	8	4	3	0	32.6
216	5.22	12.8	13.0	38	6	63	24	10	3	0	34.0
Mean± S.E.	5.50± 0.27	19.76± 2.64	12.46± 0.60	33.82± 1.96	4.18± 0.84	71.09± 2.72	19.91± 2.48	6.09± 0.80	2.91± 0.36	34.32± 1.71	34.32± 1.71

TABLE - 6 (Contd.)

1	2	3	4	5	6	7	8	9	10	11	12
					CHRONIC NEPHRITIS						
46	4.67	18.6	10.0	28.0	10	65	21	9	5	0	38
					CYSTITIS						
1005	5.62	25.4	15.4	37	2	75	20	4	1	0	15
2	6.0	23.2	16.0	40	3	73	19	4	4	0	11.8
1118	5.54	17.2	13.8	38	8	72	26	2	0	0	20
3	4.9	13.3	11.2	30	2	65	26	7	2	0	20
1237	7.2	18.0	18.0	45	3	72	22	3	3	0	14.7
235	6.25	20.2	15.3	41	2	69	18	11	2	0	18.5
282	5.22	31.0	10.0	36	4	63	18	17	2	0	15.22
4	4.6	18.0	8.9	28	3	78	19	2	1	0	16.75
5	3.56	16.8	9.5	26.2	2	79	14	2	5	0	10.0
7	5.8	16.60	10.0	36	5	70	21	5	4	0	11.7
469	3.2	7.8	7.5	22	1	70	20	8	2	0	11.5
8	7.0	31.2	13.7	40	2	82	11	4	3	0	9.5
Mean± S.E.	5.41± 0.35	19.89± 1.97	12.44± 0.96	34.93± 1.98	3.08± 0.54	72.33± 1.60	19.50± 1.23	5.75± 1.29	2.41± 0.41	Nil	14.55± 1.07
					URETHRITIS						
1075	5.2	26.2	12.6	30.0	3	78	16	4	2	0	12.6

TABLE - 7.

Showing pathogenicity test of Esch. coli isolates from urinary tract infection in dogs.

Isolates from case no.	Quantity of broth culture inoculated intraperitonially in mice.	Death in hours	P.M. lesions	Remarks.
1	1 ml 2.5 ml	18 12	Congestion of heart, kidney and liver.	Organism recovered from kidney, heart blood.
1005	1 ml 2.5 ml	18 14	-do-	-do-
3	1 ml 2.5 ml	20 13	-do-	-do-
1266	1 ml 2.5 ml	17 14	-do-	-do-
46	1 ml 2.5 ml	16 10	Congestion of heart, liver and lungs.	-do-
216	1 ml 2.5 ml	18 14	-do-	From heart and liver.
235	1 ml 2.5 ml	16 12	-do-	-do-
4	1 ml 2.5 ml	16 11	-do-	-do-
5	1 ml 2.5 ml	- -	-	No death.
6	1 ml 2.5 ml	- -	-	No death.
7	1 ml 2.5 ml	20 14	Congestion of heart, liver and lungs.	Organism recovered from heart and liver.
8	1 ml 2.5 ml	13 8	-do-	-do-
10	1 ml 2.5 ml	- -	-	No death.

TABLE - 8.

Showing result of treatment of 25 positive cases of urinary tract infection in dogs.

Case no.	Organism isolated	Degree of sensitivity to drug		Drug choosen for treatment	Duration of treatment in days.	Observations		Remarks.
						Clinical	Bacteriological	
1	2	3		4	5	6	7	8
				ACUTE NEPHRITIS				
1	Esch. coli	K	+++	Kanamycin.	5	Cure.	Sterile.	
	Staph. aureus	S	++					
		K	+++					
		S	++					
1060	Proteus vulgaris	S	+++	Streptomycin.	10	Cure.	Sterile.	After 10 days S was replaced by F.
		F	++	Furadantin.	5			
1266	Esch. coli	K	+++	Streptomycin.	18	Cure.	Sterile.	After 18 days S was replaced by K.
		S	++	Kanamycin.	8			
62	Ps. aeruginosa	F	+++	Furadantin.	10	-	-	Died on 10th day.
		S	++					
84	Ps. aeruginosa	K	+++	Furadantin.	4	-	-	After 4 day F was replaced by K, but died.
		F	++	Kanamycin.	5			
216	Esch. coli	K	+++	Terramycin.	5	Cure.	Sterile.	
		T	+++					
	Strept.faecalis	K	+++	Furadantin.				
		F	+++					

TABLE - 8 (Contd.)

1	2	3		4	5	6	7	8
364	Staph. aureus	A K	+++ ++	Ampicillin	7	Cure.	Sterile	
6	Esch. coli	K F	+++ ++	Kanamycin	5	Cure.	Sterile.	
	Proteus vulgaris.	K S	+++ ++					
464	Proteus vulgaris	F K	+++ ++	Furadantin Kenamycin	4	Cure.	Sterile.	
9	Ps.aeruginosa	A F	+++ ++	Ampicillin Furadantin	20	Cure.	Sterile.	
10.	Esch. coli	K F	+++ ++					
	Staph. aureus	K F	+++ ++	Kanamycin Furadantin	5	Cure.	Sterile.	
	Klebsiella.	K S	+++ ++					
				CHRONIC NEPHRITIS				
46	Esch. coli	K C	+++ ++	Chloramphenicol Kenamycin	8 8	Cure.	Sterile	After 8 days C was replaced by K.
				URETHRITIS				
1075	Staph. aureus	A K	+++ +++	Ampicillin Kanamycin	5 4	Cure.	Sterile.	After 5 days A was replaced by K.

TABLE - 8 (Contd.)

1	2	3		4	5	6	7	8
				CYSTITIS				
1005	Esch. coli	K C	+++ ++	Chloramphenicol Kanamycin	10 5	Cure.	Sterile.	After 10 days xhm x C was replaced by K.
2	Staph. aureus	A K	+++ ++	Ampicillin.	4	Cure.	Sterile.	
	Ps. aeruginosa	A F	+++ ++	Furadantin.				
1118	Ps. aeruginosa	F A	+++ ++	Furadantin Ampicillin	4	Cure.	Sterile.	
3	Esch. coli	K F	+++ ++	Furadantin Kanamycin	10 4	Cure.	Sterile.	After 10 days F was replaced by K.
1237	P. vulgaris	F S	+++ ++	Streptomycin Furadantin	7 7	Cure.	Sterile.	After 7 days S was replaced by F.
235	Esch. coli	K F	+++ ++	Furadantin Kanamycin	7 5	Cure.	Sterile.	After 7 days F was replaced by K.
282	P. vulgaris	S F	+++ ++	Streptomycin Furadantin	7 5	Cure.	Sterile.	After 7 days S was replaced by F.
4	Esch. coli	C K	+++ ++	Chloramphenicol Kanamycin.	15 5	Cur Cure.	Sterile.	After 15 days C was replaced by K.

TABLE - 8 (Contd.)

1	2	3		4	5	6	7	8
5	Esch. coli	A	+++					
		F	+++					
	P. vulgaris	F	+++					
		T	++	Ampicillin.				
	Ps. aeruginosa	F	++	Furadantin.	7	Cure.	Sterile.	
		A	+++					
7	Esch. coli	F	+++					
		K	++					
	Ps.aeruginosa	K	+++	Kanamycin.	10	Cure.	Sterile.	
		F	++					
469	Klebsiella.	K	+++					
		A	++	Kanamycin.				
	Strept. faecalis	K	+++		4	Cure.	Sterile.	
		F	++					
8	Esch. coli	F	+++					
		A	++	Ampicillin				
	Staph. aureus	A	+++	Furadantin	5	Cure	Sterile.	
		S	++					

K = Kanamycin. F = Furadantin. C = Chloramphenicol. A = Ampicillin. T = Terramycin (Oxysteclin
S = Streptomycin.

TABLE - 9.

I. Showing the total number of organism isolated.

Name of the organism isolated	No. of the cases (Total).	No. of the organism isolated.	Per cent
Esch. coli	25	13	36.1%

II. Table showing the mixed infection in clinical cases of urinary tract infection in dog.

Micro-organism	Esch. coli	P. vulgaris	Staph. aureus	Ps. aeruginosa	Klebsiella	Streptococcus faecalis
Esch. coli	6	2	3	2	1	1
P. vulgaris	2	4	0	1	0	0
Staph. aureus	3	0	2	1	1	0
Ps. aeruginosa	2	1	1	4	0	0
Klebsiella	1	0	1	0	0	1
Streptococcus faecalis	1	0	0	0	1	0

Diagonal figure indicates single isolates.

TABLE - 10.

Showing clinical, haematological, BUN and urinalysis values in experimentally induced bacterial nephritis in dog.

Animal number	Temperature °F	Pulse/minute	Haematological findings											BUN mg%	Urinalysis							
			T.E.C. million/cmm	T.L.C. thousand/cmm.	Hb gm %	E.S.R. mm/hour	P.C.V. %	N %	L %	M %	E %	B %		Colour	Sp.Gr.	pH	Protein	S/B/A	Blood	Pus cell/HPF	Casts/HPF	Bac
11. Male dog. (Non-descript) 2 years 16 kg.																						
(a) Before operation.	101	65	7.0	11525	14.5	2	40	67	28	3	2	0	18	Yellow	1.020	6.5	-	-	-	-	-	-
(b) Post-operation (48 hours post-infection).	104	110	6.0	39000	12.5	30	34	83	15	1	1	0	60	Blood tinged	1.040	7.5	++	-	+	+ 1-5	+ granular 5-10	+
12. Male dog. (Non-descript) 2 years 15 kg.																						
(a) Before operation.	101.5	70	7.2	17000	13.8	0	35	63	35	1	1	0	17	Yellow	1.025	6.5	-	-	-	-	-	-
(b) Post-operation (48 hours post-infection).	105	105	6.5	36050	12.6	34	31	78	18	2	2	0	58	Blood tinged	1.035	8.0	++	-	+	+ 5 - 10	+ Gross and tubular.	
13. Male dog. (Non-descript) 2 years, 18 kg.																						
(a) Before operation.	101	75	7.8	16000	14.6	2	35	69	24	3	4	0	15	Yellow	1.030	6.5	-	-	-	-	-	-
(b) Post-operation (48 hours post-infection).	105.5	115	7.0	36500	12.8	35	30	80	16	2	2	0	68	Blood tinged	1.050	8.0	+++	-	+	+ 5-10	+ granular 5-10	+

S = Sugar. B = Bile. A = Acetone.

Fig. 1.

SHOWING PERCENT INCIDENCE OF DIFFERENT BACTERIAL INFECTIONS IN URINARY TRACT DISORDERS IN DOGS.

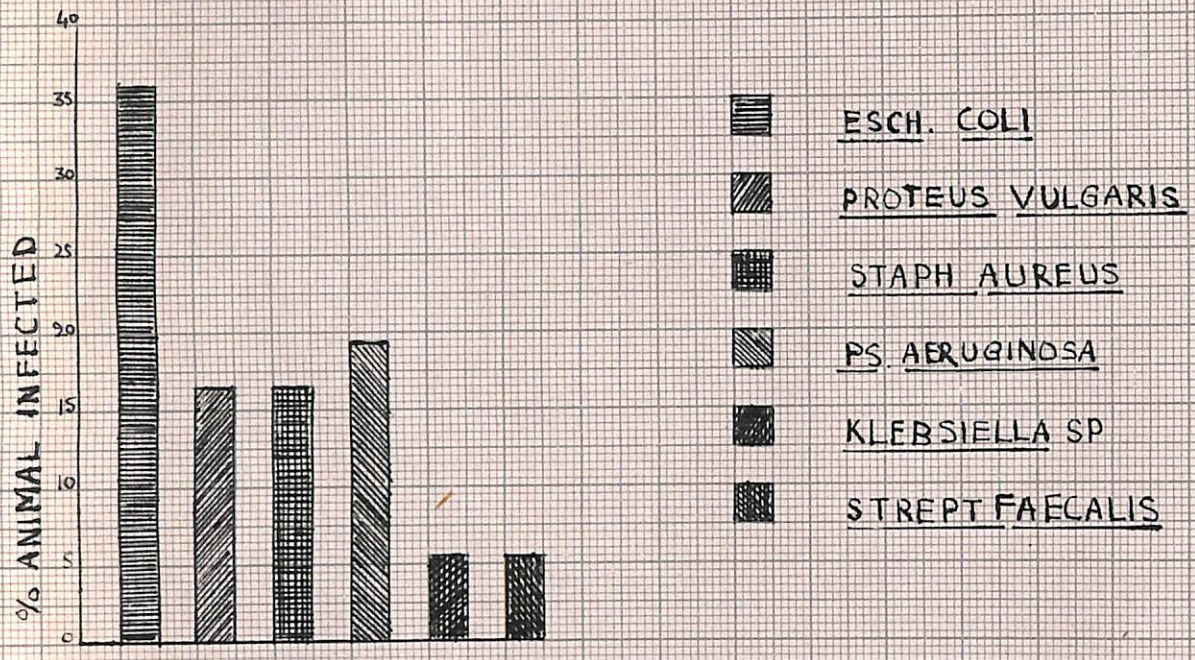


Fig. 2.

FLUCTUATION OF BODY TEMPERATURE IN ESCH. COLI INFECTION IN DOGS (CASE NO 1966)

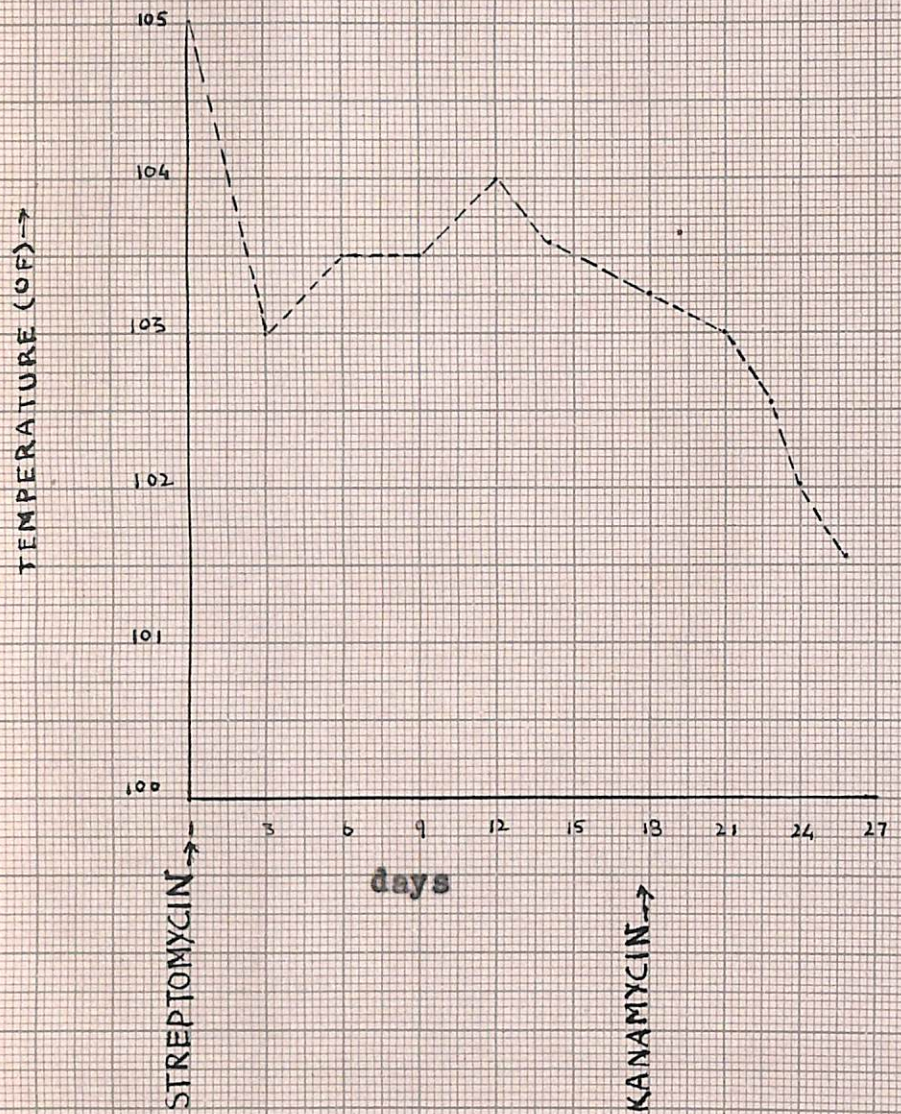
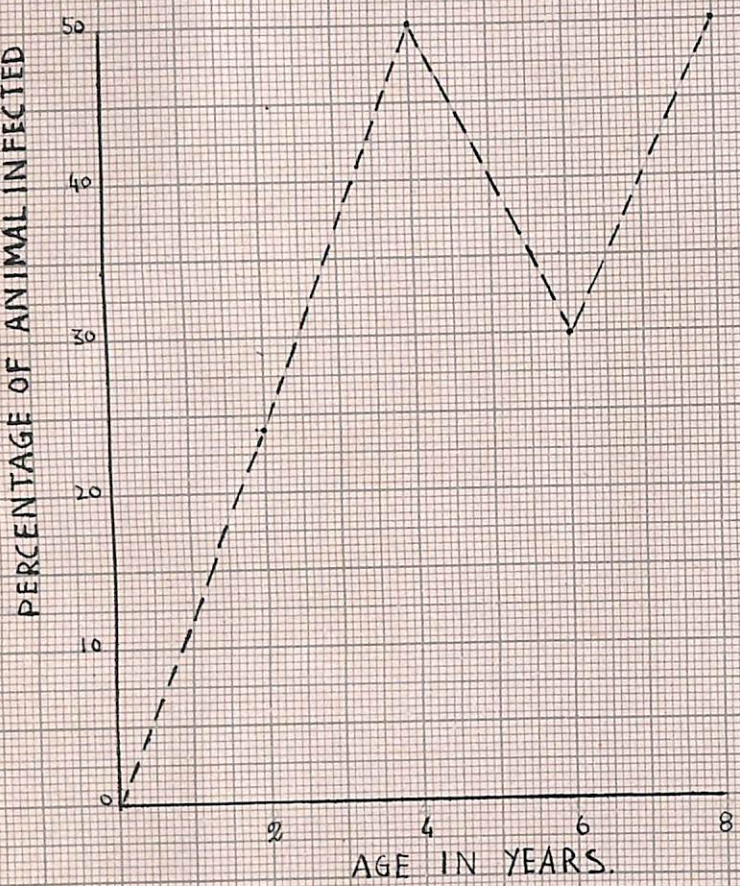
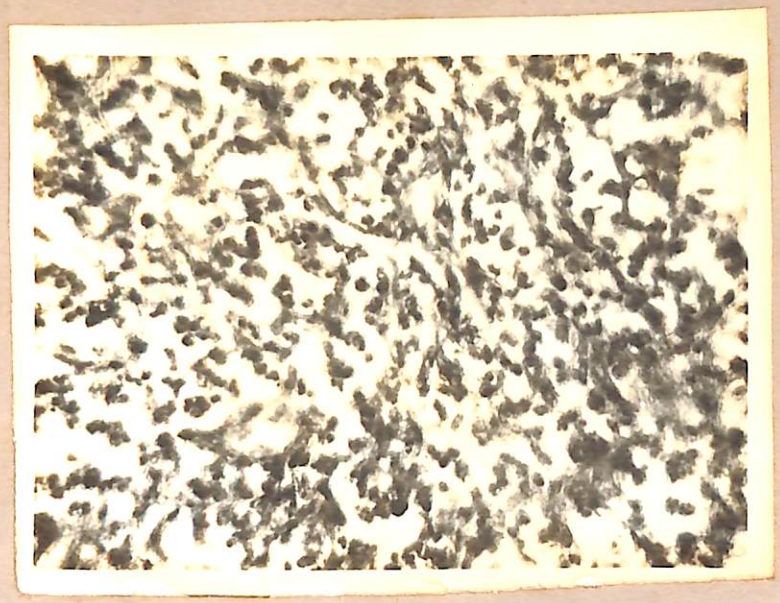


Fig. 3.

PERCENT INCIDENCE OF URINARY BACTERIAL INFECTION IN DOGS IN DIFFERENT AGE GROUPS





D I S C U S S I O N

1. INCIDENCE AND ETIOLOGY.

In the present investigation the incidence of urinary tract infection due to various micro-organisms was observed to be 36.2%. The co relation between age and incidence of the disease indicated that 50 per cent of the animals between the age group of 2 to 4 and 6 to 8 years (Fig. 3) suffered from urinary tract infection. It may be possible that the higher infection rate in the 2 to 4 years age group was due to their picking up the infection from sexual contact. The dogs between 2 to 4 years are expected to be in a state of high sexual maturity and sexual urge exposing them to a greater chance of contacting infection from infected female genitalia. Whereas, the high rate of infection in the dogs of 6 to 8 years age may have been due to their low body resistance because of advanced age. These observations, collaborate well with the findings of Bloom (1954), Piermattei (1960) and Pearson (1961) who had recorded that 80% cases of interstitial nephritis, 80% case of acute urinary tract infection and in cases of acute nephritis, the dogs belonged to the older age groups and younger ages respectively, although the chisquare test in the present investigation revealed that the difference in age groups of animal has no effect on the incidence of

urinary bacterial infection in dogs.

The observations with respect to the effect of seasonal variation in the incidence of urinary tract infection in dogs showed that out of the cases studied, about 40.7% of cases were recorded in the rainy season, whereas in summer season, the per cent incidence was 31.5. Thus, it would seem that season had a definite effect ($P > 0.01$) on the incidence of urinary tract infection. However, literature on this aspect is scanty. The highest incidence in rainy season might be due to the high rate of sexual contact during this period. Further, the survival rate of micro-organisms is more during rainy season due to increased humidity and low atmospheric temperature.

The incidence of urinary tract infection in male dogs studied in this investigation appeared to be higher (40.9%) than in females (28.0%) which supports the findings of Pearson (1961) who reported 25% higher incidence in male than in females.

Various types of micro-organisms have been found associated with the urinary tract infection in dogs, resulting in pathological disorders, such as cystitis, urethritis and nephritis. The per cent incidence of different micro-organisms has been shown in Fig. 1 which reveals that Esch. coli have been found to be associated in 36.1% cases, Streptococcus faecalis and Klebsiella sp. were recorded in

5.5% cases. The second high incidence of 19.4% was observed for Pseudomonas aeruginosa, whereas Proteus vulgaris and Staph. aureus were recorded in 16.6% cases. From urinary tract infection of dogs, Mosier (1963) demonstrated the presence of Proteus sp. (32.1%), Esch. coli (22.6%), Streptococci (20.2%) and Staphylococci (18.5%).

In nephritis, organisms isolated were Esch. coli, Staph. aureus, Proteus vulgaris, Pseudomonas aeruginosa, Strept. faecalis, and Klebsiella sp. Pearson (1961) reported that in interstitial nephritis Esch. coli, Proteus vulgaris, Streptococci and Staphylococci were commonly involved. Esch. coli was also found to be associated in cases of chronic nephritis.

In cystitis, the most common bacteria in order of occurance were Esch. coli, Aerobactor aerogenosa, Proteus sp., Staphylococci, Strept. faecalis, Salmonella morgenie, and Streptococcus lequifeciens, as reported by Morris and Franklin (1939). In the present study, organisms isolated from cystitis cases were Esch. coli, Staph. aureus, Ps. aeruginosa, Proteus vulgaris, Klebsiella sp., and Strept. faecalis. Staph. aureus was isolated from one case of urethritis.

On perusal of Table 7 it would be seem that out of 13 strains of Esch. coli isolated from urinary tract infection only 10 were pathogenic for laboratory mice. These 10

pathogenic strains were isolated from the cystitis and acute nephritis cases. The other three strains were non-pathogenic for mice and were associated with Proteus sp. and Staph. aureus infections, which apparently indicates that the Esch. coli present in these three cases played a scondary role in the causation of disease.

As would be evident from Table 9 that more than one organism were associated with the different pathological conditions of urinary tract. In this study, Esch. coli has been isolated with Proteus vulgaris (2 cases), Staph. aureus (3 cases), Ps. aeruginosa (one case), and Strept.faecalis (one case). In the cases of mixed infection it is difficult to ascertain the bacteria which might have acted as secondary invader.

2. SYMPTOMATOLOGY.

(a) ACUTE NEPHRITIS :

The clinical symptoms manifested in the cases of bacterial acute nephritis in this study were anorexia,weakness of the hind quarters, pain in the kidney region and vomition in dogs which was in agreement with the observation of Smith (1955), Pearson (1961), Colton (1963) and Kostner (1966). It would seem from Table 5, the urine samples collected from most of the cases showed proteinand renal casts. The urine in most of the cases were observed to be of high coloured. In one

bitch (No. 364) showing normal body temperature however, the urine was observed dark coloured mixed with blood. Smith(1955) also observed normal or elevated body temperature in the early stages of acute nephritis. The occurrence of haematuria in 3 out of 11 cases may have been due to the damage of glomerular and tubular capillaries precipitated by bacterial infection. In the present investigation, the body temperature and pulse rate were found increased as compared to mean normal recorded in the 6 control animals examined. Most of the animals examined showed anorexia accompanied with general depression. The above findings are in conformity with the observations of Pearson (1961).

(b) CHRONIC NEPHRITIS :

The only case of chronic nephritis in a bitch (No. 46) general weakness, dehydration, poor body condition and polyuria were observed which was in consonance with the observations of Krik (1939) and Bloom (1961).

(c) CYSTITIS :

In most of the cases of bacterial cystitis diagnosed in the present investigations as has been shown in Table 1, body temperature was recorded more than 103°F. In one case (No. 4) however a body temperature of 105°F was recorded. In 2 cases temperature remained below 103°F variation in the range of temperature was probably due to

severity, duration of infection, individual resistance and type of organism responsible for infection. It would seem from the results obtained in this study that from most of the cases showing temperature, Esch. coli have been isolated. It may be further noted that the variable body temperature observed in these cases are in full agreement with the findings of D'Souza and Raghvan (1961) who have reported clinical and bacteriological replaces in urinary tract infection caused by Esch. coli. Full, hard, regular and bounding pulse recorded in most of the cases of bacterial cystitis studied in this experiment were also in conformation with the observation of D'Souza and Raghvan (1961).

Haematuria was detected in four cases of cystitis in the present study. Hattangady and Kulkarni (1963) have also reported similar findings in 4 canine cases which were bacteriologically positive for Proteus sp. infection.

Dullness, depression, partial or complete Anorexia, painful frequent scanty urination, pain on palpation of abdomen have been observed in most of the cases studied and the above findings are in agreement with the findings of Sutherland and Smith (1945), Smith (1955) and Mather (1969). Vomition was also observed in 2 dogs which also showed abdominal pain and painful urination.

(d) URETHRITIS :

The only one dog (No. 1075) which was diagnosed

to be suffering from urethritis showed dullness, depression, anorexia and voided blood mixed urine with painful micturition however, the dog did not elicit any pain on palpation of the kidney and bladder. The painful bloody urination may indicate damaging inflammatory changes in the urethral capillaries. In the cases of urethritis Hoskins et al. (1953) also reported similar clinical signs.

At the end, it may be worth while to further mention that in both acute nephritis and cystitis cases which had infection with Pseudomonas aeruginosa and Staph. aureus, in general, showed comparatively higher range of temperature as compared to the temperature recorded in dogs infected with other organisms. The trend of the temperature was found non-fluctuating in the cases with Ps. aeruginosa and Staph. aureus infection. On the contrary, the temperature recorded in Esch. coli cases showed fluctuations (Fig. 2). In cases of acute nephritis, caused by Pseudomonas aeruginosa the urine was highly positive (+++) for protein which may indicate the occurrence of a substantial pathological changes in the kidney tissues.

The case of chronic nephritis which was studied in this investigation showed higher E.S.R. value as expected in chronic condition.

3. DIAGNOSIS (CLINICOPATHOLOGICAL FINDINGS).

In this study, altogether 69 cases which were

suspected to be suffering from some form of pathological condition of the urinary tract were screened symptomatically and by other diagnostic aids to arrive at a definite diagnosis tests of the diseased condition. Among these 69 cases, 25 were found to be suffering from urinary tract infections on the basis of cultural tests conducted on the samples of urine collected from the diseased animals. The results obtained from the bacteriological screening have been incorporated in Table 2. From the table it would be seen that 36.1%, 16.6%, 16.6%, 19.4%, 5.5%, 5.5%, cases were harbouring infection of Esch. coli, Proteus vulgaris, Staph. aureus, Pseudomonas aeruginosa, Klebsiella, Strept. faecalis respectively. This observations indicate that urinary tract infection due to Esch. coli are more common in the dogs of Patna urban area.

The haematological observations made in this study have been shown in Table 6. It is known that in cases of urinary tract infections, the haematological observations do not play a very important role in the differential diagnosis, which however is important from the prognosis point of view. The exception to the above, may be in the case of E.S.R.values which may be a point to some extent to differentiate between an acute and chronic case. In this study, the E.S.R.in case no. 46 was found higher to the extent of 10 mm per hour as compared to the mean normal value of 1.58 mm/hour indicating the case to be of a chronic nephritis. In fact the case no.

46 proved to be a case of chronic nephritis on the basis of other diagnostic aids as well. It may be interesting to note here that in the cases studied in this investigation the total erythrocyte count was found to be higher in cases of nephritis while the count fell in cases of cystitis. On the contrary, the total count of W.B.C. was higher in cases of cystitis while the count decreased to some extent in cases of acute nephritis. However, expectedly, in the cases of chronic nephritis, the total W.B.C. count was lower, while, it would be interesting to mention here that the total W.B.C. count was significantly higher in one case of urethritis, which may indicate that the case in question at the time of investigation was in the state of acute inflammatory condition.

The results obtained in the BUN concentration in different cases (Table 6) showed that BUN concentration was higher in the cases of nephritis. This was expected since in pathological changes in kidney tissues specially in cases of nephritis may have decreased partially the rate of urinary filteration of urea from the blood resulting in the slight rise of its concentration in the blood. This observation is in agreement with the findings of Richard (1967). This increase in the BUN concentration in the cases of nephritis may have been further accentrated due to the increased rate of the production of urea by the erythrocytes. In this experiment as has been referred earlier in cases of nephritis - the total erythrocytes count was higher and this increased

number of erythrocytes may have played an important role in the increased production of urea.

The results of qualitative examination of the urine samples (Table 5) showed that in 33.3% of cystitis and in 100% of acute nephritis cases proteinuria was present. It was in the conformity with the type of disease, since the kidney tissue undergoes degenerative changes in cases of acute nephritis causing impaired renal filtration to the extent that proteins of higher molecular weight are also filtered out through the damaged glomerulus thus increasing the concentration of observable protein in the urine. In the few cases of cystitis in which proteinuria was present may have been due to the stagnation of urine in the bladder thus increasing the observable filtrable protein in the voided urine. It may be mentioned in this context that normal urine contains about 5 mg of protein of which 60% has electrophoratic mobility for albumen (Wilkinson, 1969), although this conclusion does not express itself in the qualitative test which is normally carried out to identify the presence of protein in the urine. The results of microscopic examination of urine have been shown in Table 5. It would be evident from the table that in most of the cases of acute nephritis, granular, epithelial and tubular casts were predominently present. This observations contributed to the diagnosis of such cases. In most of cystitis cases transitional epithelial cells which form the mucosa of the bladder were present in the urine and thus

helped in the diagnosis of this condition.

In one case of chronic nephritis hyaline casts were abundantly present whereas in the case of urethritis, squamous epithelial cells were present. These observations contributed to the diagnosis of the different diseased conditions. It may be worthwhile to mention here that the case no. 46 also had a urine pH of 6.5 which was much lower as compared to the cases of acute nephritis and cystitis. The presence of higher cast in this case thus was expected since the hyaline casts are insoluble in acidic pH of urine and consequently appearing in the urine sediments.

4. CHEMOTHERAPY.

It would seem from the results obtained in this study that Pseudomonas aeruginosa was a causal organism for both nephritis and cystitis along with other pathogenic organisms. In nephritis, Pseudomonas was not amenable to Kanamycin, which however, proved effective in controlling Pseudomonas in cystitis. From the results, it may be interresting to note that although Kanamycin was inhibitory to Pseudomonas in cystitis, the duration of the disease prolonged for ten days whereas Kanamycin cleared Esch. coli, Strept. faecalis, Staph. aureus, and Proteus vulgaris infections within a period of 4 to 5 days. It may be further noted that Ampicillin combined with Furadantin controlled Pseudomonas

infection in 7 days and 20 days in cystitis and acute nephritis cases respectively. A case of acute nephritis having Pseudomonas infection when treated with Furadantin (showing highest activity on sensitivity test) did not recover and died on the 10th day. These observations point out that inspite of highest in-vitro activity, Furadantin was ineffective in controlling in-vivo Pseudomonas infection whereas Ampicillin along with Furadantin was decisively effective. A point worth mentioning here is that the dog suffering from acute nephritis and treated with only Furadantin showed decreased temperature after 4 days of treatment but the condition subsequently detoriated. This may have been due to the fact that due to acute renal impairment the Furadantin urinary clearance was decreased rendering the drug ineffective. Further, the organism involved in this case may have developed resistance to Furadantin and contributed to the ineffectiveness of the drug. In the dog in which Ampicillin and Furadantin were tried combinedly however, the situation was different and the animal was cured in twenty days time clearly indicating that Ampicillin played a decisive curative role in this case.

It may be further noted here that in the cases of cystitis having Pseudomonas infection, Ampicillin and Furadantin combined administration in general cured the cases within 4 to 5 days in contrast to the case of acute nephritis in which cure was noticeable in 20 days. This variation in the duration of the disease may be attributed to the fact that a case of acute

nephritis in general is more pathologic than a case of cystitis. Also it seems logical that there is a comparatively better chance of bacterial inhibition and flushing out of the organisms in a case of cystitis than in a case of actue nephritis. A bacterial foci located in the urinary bladder will be exposed to the drug for a long spell of time due to the accumulation of the unchanged drug molecules in the urine than in a case of nephritis where the drug attacks the organisms while being filtered through the uriniferous tubules and also through the blood circulation in which the drug concentration plays an important role.

It may be further noted that acute nephritis and cystitis cases which had infections with organisms other than Pseudomonas aeruginosa were cured in a short period when Ampicillin and Kanamycin was tried. This was expected since Pseudomonas is one of the most stubborn organisms and is amenable to polymixin therapy only. Colton (1963) reported similar observation regarding the cure of a cystitis case harbouring Pseudomonas aeruginosa in a dog with Polymixin. He failed to cure this case with Penicillin, Dihydrostreptomycin, Cosaterramycin (Pfizer) Chloromycetin and Colymycin. The results in this study, however, were encouraging in that, that Ampicillin, a benzyl penicillin analogue obtained by the action of various acylating agents on 6-aminopenicillanic acid and having a susceptibility to Penicillinase activity proved effective against Pseudomonas aeruginosa which is considered

to be one of the most stubborn type. We know that one of the most important factor responsible for the Gram-negative organisms being not susceptible to Penicillin is that the Gram-negative organisms, in general, have the characteristic of secreting more Penicillinase as compared to Gram-positive organisms.

The only case of urethritis recorded during the course of the investigation was found to harbour Staphylococcus aureus infection. In this case, ampicillin proved ineffective inspite of its administration for five days. This ineffectiveness may have been due to the breakdown of the Ampicillin by the Penicillinase enzyme apparently elaborated in large amounts by the strains of Staphylococcus infection with which the dog suffered. This was in confirmation with the findings of Klein and Finland (1963) who have reported that Ampicillin was rendered ineffective by Penicillinase and as such Staph. and other Penicillinase producing bacteria are difficult to be cured by this drug. The presumption thus made seems to be strengthened by the fact that when Kanamycin which is not vulnerable to Penicillinase was tried for 4 days, the dog recovered. It may also be worthwhile to mention here that a dog suffering from acute nephritis with Staph. aureus infection responded to Ampicillin therapy. This effective response elicited by Ampicillin might have been due to the fact that in this case, the concerned strain of Staph. aureus might have belonged to a bacteriophage group which did not produce

Penicillinase enzyme. We know that Staphylococci of bacteriophage 1 and 3 only produced this enzyme (Dubos and Hirsch, 1966). In this investigation, two cases of cystitis and one of chronic nephritis caused by Esch. coli chiefly sensitive to Chloramphenicol, when treated with the drug did not show appreciating result. Similar cases of cystitis suffering from Esch. coli, when treated with Furadantin also did not recover. In all these five cases, however, when Kanamycin was tried, the animals showed improvement and the urine samples became sterile. Thus it would be apparent that in Esch. coli infected chronic nephritis and cystitis cases studied in this investigation, Kanamycin proved to be the most potent and effective. The ineffectiveness of Chloramphenicol in the three cases which showed sensitivity to the drug in-vitro, might have been due to the development of resistance by the strain of Esch. coli involved. Generally, Esch. coli insensitivity to Chloramphenicol is due to the presence of a resistance factor acquired by conjugation with micro-organisms containing this factor. This resistance may have been due to the presence of or speady elaboration of acetyl-transferase by the strains of Esch. coli and thus acetylating the drug and rendering it therapeutically inactive. The acetylation of Chloramphenicol by the resistant strains of Staph. aureus have been reported by Shaw and Brodsky (1968). The ineffectiveness of Furadantin however, may not be due to resistant factor since bacteria develops only a limited resistance to Furan derivatives. Sachs et al.

(1968) have reported that the urinary recovery of NFT (Furadantin) is linearly related to creatinine clearance. As such, quite appropriately the drug is likely to be ineffective in patients with impaired renal function. These two cystitis cases which proved refractory to Furadantin treatment might have been suffering to high degree of latent renal impairment thus rendering the urinary excretion of Furadantin and making thus the drug ineffective against the Esch. coli which were located in the urinary tract.

In this experiment, two cases of cystitis and one case of Nephritis which showed infection with Proteus vulgaris were treated successfully with Furadantin. In these cases the ineffectiveness of Streptomycin which was tried first may be explained from the stand point that Proteus vulgaris shows wide variation in its susceptibility to this drug (Weinstein, 1970).

EXPERIMENTAL BACTERIAL NEPHRITIS.

In the present study attempts have been made to produce nephritis in two dogs by infecting 2 ml of 24 hour broth culture of Pseudomonas aeruginosa through I/V routes. The urine samples collected each day for 10 days from these two dogs proved sterile on cultural examination indicating that the dogs did not pick up the infection. In view of the above, attempts were made to induce infection through the renal artery. For this 1 ml of bacterial culture was injected

into the renal artery of each dog. The surgical methods adopted in doing this have already been discussed earlier.All the three dogs which were used in this experiment picked up the infection within 48 hours post-bacterial culture administration and the disease syndrome was evidenced by typical, clinical symptoms and also by cultural examination of urine sample. Coles and Mosier (1959), Sastry (1961), and Gold (1968) have also produced bacterial nephritis by injecting in renal artery pathogenic organisms which included Proteus sp., Esch. coli, Ps. aeruginosa and mixed culture of Esch. coli and Staph. aureus.

In this study it was interesting to note that the symptoms observed at 48 hours after induction of infection in all the three dogs were rise in body temperature ranging between 104 to 105.5°F, which however, was higher than the temperature recorded in clinical cases of nephritis (103 to 104.5°F) caused by Ps. aeruginosa. This may indicate that the severity of pathogenesis was more acute in nature in these cases then the clinical cases studied in this investigation. This was possible since the broth culture which was injected confined rapidly multiplying bacteria and might have caused a virulent bacteraemia causing a high rise in temperature.

E.S.R. values were found elevated in all the three experimental dogs. This elevation of E.S.R. might have been due to haemoconcentration and acute inflammatory changes of the kidney tissues. There is always a tendency of aggregation

of Red Blood Cells in acute and generalized infection as also in cases of considerable tissue destruction brought about by inflammation (Schalm, 1965; Smith, 1969). Thus, the increase in E.S.R. causation of Neutrophilic leucocytosis and the fall in T.E.C. as has been observed in these three experimental dogs as compared to the clinical cases may suggest a highly acute condition of the disease in artificially infected situations. The rapid increase of BUN value upto 68 mg % in Dog No. 13 is higher than the value recorded in clinical cases. This might have been due to the increased production of Ammonia from the pathological kidney tissues which seemed to harbour Ps. aeruginosa on autopsy. In contrary to this, the BUN were observed to be less in clinical cases of nephritis. The rise in BUN in almost all the three artificially infected cases of nephritis however, might have been due to the bilateral involvement of kidney. Koles and Mosier (1959) also holds the similar views. Haematuria and Protein-uria are the result of glomerular and tubular capillaries damage. In this study, haematuria was present (++) in all the cases whereas among the clinical cases studied (Table 5 and 8) one case (No. 62) showed haematuria. It may be apparent then that in the experimentally induced cases of bacterial nephritis, the kidney glomerular damage was of greater degree facilitating leakage of red blood cells.

It was apparent from Fig. 5, 6, 7 and 8 that in experimentally induced bacterial nephritis (Dog No.13), the

nature of the lesion in kidney was of acute suppurative type whereas in clinical cases of acute nephritis (Dog No. 62), the lesion was of milder degree (Fig. 4) as indicated by degenerative changes in the cortical tubules but not suppuration as in Dog No. 13.

It would be interesting to mention here that in one clinical case of bacterial nephritis, in which, Ampicillin and Furadantin was used, cure was effected in 20 days whereas in the experimentally induced nephritis cases, when Ampicillin and Furadantin was tried, the two animals thus treated cured in 18 days inspite of the fact that the course of disease in these two dogs was more severe than in clinical cases.

The present experimental work which was undertaken to determine whether it was possible to produce nephritis by injecting bacterial culture into blood thus showed that infection is set in only when the bacterial culture is put into the renal artery. The type of symptoms noted in experimentally induced cases indicated the course of the disease to be of highly acute in nature whereas in comparison to this, the clinical cases showed a milder degree of severity. Above findings may thus expectedly focus some of the important pathognmonic clinical and laboratory findings to the clinicians to help and enable them to evaluate to some extent the degree in the severity of the bacterial nephritis cases which are referred to them from time to time.

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S U M M A R Y

SUMMARY

1. The study into the incidence of bacterial urinary tract infection in the canine cases brought for the treatment at the Bihar Veterinary College Hospital, Patna revealed that the pathogens chiefly involved were Esch. coli (36.1%), P. vulgaris (16.6%), Staph. aureus (16.6%), Ps. aeruginosa (19.4%), Klebsiella (5.5%) and Streptococcus faecalis (5.5%).

2. The results obtained in the present study showed that age, season and sex played an important role in the per cent incidence of the urinary tract infection of canine.

(a) The dogs of age group between 2 to 4 and between 6 to 8 years showed a vulnerability to infection.

(b) The per cent incidence of the infection as obtained, indicated that more cases were recorded in the rainy season than in summer.

(c) The male dogs (40.7%) appeared to be more susceptible to the urinary tract infection than the bitches (28.0%).

3. It was observed that 36% of the suffering cases harboured mixed bacterial infection in which Esch. coli was predominantly involved.

4. Only one case of chronic nephritis due to Esch. coli and one of urethritis caused by Staph. aureus has been recorded.

5. Haematuria in 3 cases of bacterial acute nephritis and in 4 cases of bacterial cystitis have been observed.

6. In both, acute nephritis and cystitis cases which had infection with Ps. aeruginosa and Staph. aureus, in general, showed comparatively higher range of temperature as compared to the temperature recorded in dogs infected with other organisms. The trend of temperature was found nonfluctuating in cases with Ps. aeruginosa and Staph. aureus infection, whereas the temperature recorded in Esch. coli cases showed fluctuations/variations.

7. In cases of acute nephritis, caused by Ps.aeruginosa, the urine was highly positive (+++) for protein. All the 11 cases showed presence of renal casts and pus cells.

8. Haematuria was present in all the experimentally infected cases.

9. Most of the cases diagnosed as cystitis showed the presence of transitional epithelial cells and pus cells.

10. No significant diagnostic changes have been recorded in cystitis, acute nephritis, chronic nephritis and urethritis cases except that a moderate increase in mean TLC and neutrophil count in diseased animals as compared with mean value of 6 control animals. However, ESR value was found increased in one case of chronic nephritis. Mean BUN value was observed to be higher (34.32 mg %) as compared to mean normal (11.58).

The ESR, TLC and BUN values was higher in the experimental cases in comparison to the clinical cases.

11. It was found that in the cases of cystitis having Ps. aeruginosa infection, Kanamycin proved efficacious.

12. The chemotherapeutic observations indicated that -

(a) Kanamycin cleared, Esch. coli, Streptococcus faecalis, Staph. aureus and Proteus vulgaris infection within a period of 4 to 5 days.

(b) Ampicillin combined with Furadantin controlled Ps. aeruginosa infection in 7 and 20 days in cystitis and acute nephritis cases respectively.

(c) It would be apparent from the result that in Esch. coli infected chronic nephritis and cystitis cases, Kanamycin proved to be the most potent and effective.

(d) In general, cases of cystitis and acute nephritis with P. vulgaris infection could be successfully treated with Furadantin. Streptomycin however showed no effect in P. vulgaris infection.

(e) In the experimentally produced bacterial nephritis cases, Ampicillin and Furadantin combined therapy was 100% effective.

13. In the present study broth culture of Ps. aeruginosa injected through I/V route failed to produce nephritis whereas when given through the renal artery, the disease was established. In contrast to the clinical cases, in the experimentally

induced cases the disease was of more acute nature. The acuteness was further confirmed by the fact that in the experimentally produced bacterial nephritis, the nature of lesion in kidney was of acute suppurative type which indicated that the disease was of more acute in nature than clinical cases.

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