DISCUSSION

A considerably large number of clinical cases were being reported to the Ranchi Veterinary College Hospital, Kanke, Ranchi with the complaint of renal failure symptoms. But we are not in a position to treat such type of cases successfully prior to the present study.

Renal failure of infectious or non-infectious origin is common in small animals (Kelly, 1984). It is broadly divided into two parts i.e. Acute and Chronic renal failure. Acute renal failure (ARF) is usually caused by an ischemic or toxic insult that results in an abrupt decline in renal function over a period of hours to days (Kraje, 2002). Chronic renal failure is the primary renal failure that has prevailed for a lengthy period, usually months to years. Irrespective of the causes, CRF is characterized by irreparable renal injury and reduction in renal mass (Rubin, 1997). Renal function cannot be expected to improve any further in patients with CRF following the correction of reversible primary diseases and pre or post renal component of renal dysfunction (Polzin et al., 2005). In contrast to CRF, acute renal failure (ARF) is potentially reversible if the animal survives until the underlying condition resolve and natural recovery (repair) of the renal injury takes place (Cowgill and Francy, 2005).

In the present study, a total number of 25 clinical cases of ARF were screened from 150 general clinical cases coming to Ranchi Veterinary College hospital. These 25 clinical cases were divided into 5
groups (T1, T2, T3, T4 and T5) consisting of 5 dogs in each group. T1, T2 and T3 were kept under conservative treatment group while T4 and T5 were kept on dialytic treatment group.

Acute renal failure classically proceeds through three clinical phases; initiation, maintenance and recovery. The best time to intervene and stop the progression of ARF is the initiation phase where the initial injury can be minimized. The success of treatment depends largely on the selection of suitable conservative treatment and frequency of dialysis with respect to severity of the case. Fluid therapy along with furosemide is being widely used by veterinary physicians to initiate diuresis in oliguric/anuric patient where as low dose dopamine with minimal systemic effect has shown some result. Recently, a combination of dopamine and furosemide is being considered to manage the ARF cases in a better way.

Haemodialysis and peritoneal dialysis have been used extensively in human medicine as a method of extra renal means of excretion of metabolic waste product in the recent year but to a limited degree in the dogs. Peritoneal dialysis is a simple procedure, equally effective and comparatively less expensive than haemodialysis which is expensive and required trained technicians and sophisticated instruments. Unfortunately, peritoneal dialysis in veterinary practice often is not considered as a routine measures until the patient reaches to the critical conditions which might be due to technical and non-technical awareness in the clinicians and owners of the patients. With due importance to these
aspect of management of ARF, the clinical cases in the present study were divided on the basis of severity of the cases with respect to BUN and serum creatinine levels into conservative (BUN<100 mg/dl and S.C.<6 mg/dl) and dialytic (BUN>100 mg/dl and S.C.>6 mg/dl) treatment groups.

The present study was undertaken keeping in view the above facts to evaluate the efficacy of conservative and dialytic treatment in ARF cases.

Diagnosis of renal failure:

The serum creatinine and BUN levels were used to diagnose renal failure in the present study.

Creatinine is formed in the muscle from non-enzymatic degradation of creatine and is freely filtered by the glomerulus and appears in the same concentration as in plasma. Creatinine is neither reabsorbed nor secreted by the tubules of the Kidneys (Finco, 1995). Formation of creatinine is not affected by dietary proteins, protein metabolism, age, sex or exercise (Benjamin, 1985). Hence rise in serum creatinine levels is considered a sure indication of kidney dysfunction. Scott et al. (1985) and Shivakumar (2001) had taken serum creatinine >2 mg/dl as azotemia and Behrend et al. (1996) have considered the dogs to have renal failure if they had a serum creatinine concentration >2.5 mg/dl.
Urea is non-protein nitrogenous substances produced by the liver from ammonia during catabolism of amino acid and excreted exclusively by the kidney. (Finco, 1995; Osborne and Polzin, 1998). Urea is distributed throughout total body water and is equal in concentration in the intracellular and extra-cellular fluid. Thus its concentration is the same in whole blood, plasma and serum. Abnormal elevations in the concentration of BUN which occurs as a result of impairment of renal function are not detectable until approximately 70 to 75% or more of the nephrons of both kidneys become non-functional (Osborne et al., 1972). Hence abnormal rise in BUN is indicator of renal dysfunction.

Finco and Dunkan (1976) had taken BUN > 35 mg/dl as azotemia while Thrall et al. (1984) have considered the dogs to have renal failure if they had a BUN concentration > 30 mg/dl.

Clinical observations

The clinical signs observed in dogs suffering from ARF were anorexia, weakness, depression, vomition, diarrhoea, dehydration, uremic breath, subnormal temperature, elevated respiratory and pulse rate. Almost similar findings were reported by English (1974), Donald and Larry. (1983), Shahar and Holmberg (1985), Joshi et al. (1989), Mary (1992), Clement et al. (1993), Forrester and Brandt (1994) and Cowgill and Francy (2005).
Temperature:

In the present study, mean values of temperature revealed highly significant (P<0.01) variation in both conservative (T1, T2 and T3) and dialytic (T4 and T5) treatment groups. Before treatment lower temperature was recorded in T1, T2, T3, T4 and T5 groups which were 99.65±0.38, 99.50±0.34, 99.60±0.42, 99.8±0.29 and 99.64±0.38ºF respectively. Comparatively higher temperature was recorded in the same group T1, T2, T3, T4 and T5 after treatment and the values were 101.05±0.15, 101.2±0.29, 101.3±0.17, 101.3±0.20 and 101.4±0.26ºF respectively. Lower temperature in ARF dogs might be due to nephrosis, depression and sedative effect of toxicants. These findings are in accordance with Joshi et al. (1989), Kraje (2002) and Cowgill and Francy (2005) who reported hypothermia in acute renal failure cases.

Chew et al. (2002) reported that hypothermia (98 to 100ºF) is often seen in ARF dogs due to nephrosis. Whereas Thrall et al. (1984) reported that hypothermia may be attributed to depression, coma and the sedative effects of ethylene glycol in ARF dogs associated with ethylene glycol intoxication.

Respiratory rate (Per minute):

In the present investigation mean values of respiratory rate/minute revealed highly significant (P<0.01) variation in both conservative (T1, T2 and T3) and dialytic (T4 and T5) treatment groups.
Before treatment higher respiratory rate was recorded in T1, T2, T3, T4 and T5 groups which were 27.5±0.95, 28.±1.08, 27.25±1.25, 28.25±0.62 and 27.8±0.66, respectively. Comparatively lower respiratory rate was recorded in the same groups T1, T2, T3, T4 and T5 after treatment and the values were 22.25±0.95, 21.25±1.10, 22.25±1.03, 22±1.08 and 21.4±0.75, respectively. Increase in respiratory rate before treatment might be due to the progressive development of metabolic acidosis (Cowgill and Francy, 2005) and terminal dehydration (Joshi et al., 1989). These findings are in accordance with English (1974), Mahajan (2000) Kraje (2002) and Kaushik (2004).

After treatment the mean values of respiratory rate decreased significantly (P<0.01) which was almost normal in all the treatment groups. The improvement following therapy might be due correction of metabolic acidosis and dehydration Mahajan (2000) and Kaushik (2004) also observed the similar findings in acute renal failure dogs after treatment.

Pulse rate (Per minute) :

In the present study, mean values of pulse rate/minute revealed highly significant (P<0.01) variation in both conservative (T1, T2 and T3) and dialytic (T4 and T5) treatment groups. Before treatment higher pulse rate was recorded in T1, T2, T3, T4 and T5 groups which were 103.5±22, 104.25±1.6, 1.03±2.38, 106±1.82 and 107.2±1.15,
respectively. Comparatively lower pulse rate was recorded in the same
groups T1, T2, T3, T4 and T5 after treatment and the values were
90.5±0.95, 91.75±0.85, 91±1.08, 92.75±0.47 and 91.40±0.67,
respectively. Increase in pulse rate before treatment might be due to
terminal dehydration. These findings are concordance with English
(1974), Joshi et al. (1989), Kaushik (2004) and Cowgill and Francy
(2005).

After treatment the mean values of pulse rate decreased
significantly (P<0.01) which was almost normal in all the treated groups.
Kaushik (2004) also observed the similar findings in ARF dogs.

Haematological observations :

Haemoglobin (Hb), Packed Cell Volume (PCV) and Total Erythrocyte Count (TEC):

In the present investigation, the mean values of Hb, PCV and TEC revealed non-significant variation among groups and treatment intervals in conservative group. Similarly, in dialytic group the above parameters showed non-significant difference between groups and treatment intervals. However, a slight reduction in Hb, PCV and TEC values was observed on day “3”, of treatment then gradually increased upto 9th day of experiment of both the groups, the higher initial mean values of Hb, PCV, and TEC in ARF dogs might be due to dehydration.
Cowgill and Francy (2005) reported that at initial examination most animals with ARF were dehydrated and hypovolemia due to active fluid loss (Vomiting, diarrhoea and possibly haemorrhage).

These findings were in accordance with the findings of Ganesh et al. (1981), Rukdikar (1982), Maruthy (1982), Clement et al. (1993) and Dighe et al. (1990) who observed no appreciable changes in Hb, PCV and TEC after treatment.

Cowgill and Francy (2005) reported that normal or increased Hb, PCV and TEC values are consistent with ARF, where as Grauer (1998) reported normal or increased PCV in ARF cases.

Total Leucocyte Count (TLC)

In the present study, the mean TLC values revealed non-significant variation among groups and treatment intervals in conservative group. Similarly in dialytic group, the mean TLC values showed non-significant difference between groups and treatment intervals. Similar findings were observed by Ganesh et al. (1981), Rukdikar (1982), Dighe et al. (1990) and Clement et al. (1993) who did not find any appreciable change on TLC values in ARF dogs after treatment. However, a mild to severe leucocytosis (35.30±4.18 x 10³/μl) was noticed in 8 out of 21 ARF cases as compared to healthy control (9.53±0.75x10³/μl) which progressively declined towards normal level on 3rd, 6th and 9th day of post treatment.
Increased total leucocyte count generally indicates presence of inflammation, which may either have an infectious or a non-infectious cause. In patient with renal failure, leucocytosis often is mainly due to inflammation in one or more other organ system. When leucocytosis is caused by inflammation within the urinary system, the site of inflammation generally is in parenchymal tissue rather than in the excretory pathway (Osborne et al., 1995; Hurley, 1998). Polysystemic diseases such as bacterial endocarditis, pyometra and leptospirosis which involve urinary system are often associated with leucocytosis (Osborne et al., 1972) and many bacterial infections like *E. coli*, *streptococcus sp.*, *staphylococcus sp.*, *Proteus sp.* and *Klebsiella sp.* are documented as cause of ARF (Mary, 1992). Behrend et al. (1996) noticed secondary bacterial infection in 8 out of 29 cases suffering from ARF and 17 cases of leucocytosis have been documented by Christopher and Larry (2000) in 37 azotemic cases caused by leptospirosis.

Coles (1986) documented leucocytosis in renal failure cases due to typical stress reaction of uremia.

The present findings are also in accordance with the findings of DiBartola et al. (1985), Joshi et al. (1989), Jayathangaraj et al. (1995) and Mrudula et al. (2005) who observed leucocytosis in renal failure cases.

Differential leucocyte count (DLC):
In the present investigation, the mean DLC values revealed non-significant variation among groups and treatment intervals in conservative group. Similarly in dialytic group, the mean DLC values showed non-significant difference between groups and treatment intervals. Similar observations were made by Ganesh et al. (1981), Rukdikar (1982), Dighe et al. (1990) and Clement et al. (1993) who recorded no appreciable change on DLC values in ARF cases in dogs. However, out of 21 ARF cases, nine cases showed neutrophilia and lymphopenia with a mean of 83.33±0.99 and 10.89±0.69% as compared to healthy control 62.20±1.16 and 27.4±1.80%, respectively. After 3rd, 6th and 9th day post treatment, the mean neutrophil count showed a gradual decrease while lymphocyte count gradual increase and tendency to return towards the normal levels. The drop in neutrophil count and increase in lymphocyte count may be attributed to the decrease in circulating corticosteroids in the body (Kociba, 2000). The corticosteroids are released during stressful stimulation of pituitary adrenal axis.

Thrall et al. (1984) reported that neutrophilia and lymphopenia observed in renal failure cases were attributed to endogenous corticosteroid release. They also reported that lymphopenia may be due to stress reaction of uremia. Joshi et al. (1989) reported that leucocytosis and neutrophilia in renal failure cases seems to be a result of kidney damage as neutrophil are recognized as the main cell of protection of urinary tract.
The present findings agree with the observations of earlier workers like Stevenson (1980), DiBartola et al. (1985), Joshi et al. (1989), Ihle and Kostolich (1991) and Mrudula et al. (2005) who also observed neutrophilia and lymphopenia in renal failure cases.

Biochemical observations:

Blood urea nitrogen (BUN):

(A) Conservative treatment group (T1, T2 and T3):

In the present investigation, mean blood urea nitrogen revealed significant variation among groups and treatment intervals.

Under dopamine groups (T1), BUN levels (mg/dl) declined significantly on 3rd (71.08±3.5), 6th (49.98±3.41) and 9th (28.95±2.21) day of post treatment as compared to "0" day value (88.29±4.10). This might be due to diuretic effects of dopamine. Low dose of dopamine (0.5 to 3 \( \mu \)g/kg/minute) infusion causes renal vasodilatation, increased renal blood flow, increased GFR, induced natriuresis and diuresis (Denton and Brady, 2003).

The above findings were simulated with Varriale and Mossavi (1997) who worked on congestive heart failure associated with renal insufficiency. They observed reduction in BUN and serum creatinine levels in dopamine treated group as compared to control group.

Kapoor et al. (1996) studied of low dose dopamine in the prevention of contrast medium induced ARF. They found reduction in
BUN and serum creatinine levels in dopamine treated group as compared to control group.

The present findings are also in accordance with Lane et al. (1994), Labato (2001), Chew et al. (2002), Kraje (2002) and Cowgill and Francy (2005) who reported diuretic effect of dopamine therapy in renal failure cases.

Similarly, under furosemide group (T2) BUN levels (mg/dl) declined significantly on 3rd (37.19±4.6), 6th (45.33±3.45) and 9th (25.6±3.4) day of post treatment as compared to “0” day value (90.74±4.30). This might be due to diuretic effects of furosemide.

Furosemide is a loop diuretic that causes increased excretion of water, sodium, chloride, potassium, calcium and magnesium. It causes some dilation of renal veins, increases renal blood flow and transiently increases GFR (Kraje, 2002). Furosemide is the diuretic of choice in oligouric ARF (Mary, 1992). Accordingly in the present study four out of five ARF dogs responded to diuretic treatment with furosemide.


While, under dopamine and furosemide group (T3), BUN levels (mg/dl) declined significantly on 3rd (49.53±4.69), 6th (29.53±2.85)
and 9th (22.16±2) day post treatment as compared to “0” day value (91.41±5.1). This might be due to synergistic effects of dopamine and furosemide. Similar findings were also observed by Lindner (1979), Graziani et al. (1983), Ihle and Kostolich (1991) and Shivakumar (2001).

The present findings are also in accordance with Grauer (1989), Grauer and Lane (1995b), Grauer (1998), Lane and Grauer (1994), Labato (2001), Chew et al. (2002) and Macintire et al. (2005) who also recommended the use of dopamine and furosemide combination to induce diuresis in oligouric ARF cases.

In the present study, BUN levels revealed significant variation among groups. BUN levels of dog treated with combination of dopamine and furosemide (T3) group on 3rd and 6th day of post-treatment were significantly lower (49.53±4.69 and 29.53±3.41 mg/dl) than those treated with dopamine (T1) and furosemide (T2) separately and the values recorded on 3rd and 6th day were 71.08±3.5 and 49.08±3.41 mg/dl in T1 group and 67.19±4.6 and 45.33±3.45 mg/dl in T2 group respectively.

These results revealed maximum reduction in BUN levels among dogs treated with a combination of dopamine and furosemide (T3) right from 3rd post treatment day indicating that, a combination of dopamine and furosemide (T3) therapy was having better results as compared to dopamine (T1) and Furosemide (T2) alone. Graziani et al.
(1983), Ihle and Kostolich (1991), Lindner (1979) and Shivakumar (2001) also observed similar findings in acute renal failure cases after treatment.

(B) Dialytic treatment group (T4 and T5):

In the present study, mean blood urea nitrogen levels revealed significant variation between groups and treatment intervals.

Under peritoneal dialysis twice daily (T4), BUN levels (mg/dl) declined significantly (P<0.01) on 3rd (60.90±2.59), 6th (32.74±1.49) and 9th (23.80±1.29) day post treatment as compared to “0” day value (117.85±3.53). Similarly peritoneal dialysis four times daily (T5), BUN levels (mg/dl) reduced significantly on 3rd (37.58±8.01), 6th (20.28±1.42) and 9th (18.03±0.47) day post treatment as compared to “0” day value (129.96±9.20). However, in between experimental group (T4 and T5) significant variation in the levels of BUN were observed. BUN levels of dog treated with peritoneal dialysis 4 times daily on 3rd, 6th and 9th day of post treatment were significantly lower as compared to peritoneal dialysis twice daily.

These results revealed maximum reduction in BUN levels among dogs treated with peritoneal dialysis 4 times daily right from 3rd post treatment day indicating that, peritoneal dialysis 4 times daily had better response as compared to peritoneal dialysis twice daily. Similar findings were also observed by Dighe et al. (1990) who recorded significant (P<0.05) declined in mean values of BUN from 165.38 to 62.71
mg/dl in dogs in which dialysis was done once daily and from 151.60 to 42.62 mg/dl in dogs in which dialysis was done twice daily for 4 days.

Mahajan (2000) observed the reduction of BUN values from 130 to 20 mg/dl after 3rd day of dialysis with 8 consecutive exchanges per day. Where as Jackson (1964) observed reduction of blood urea values from 380 to 70 mg/dl after 10 exchanges with irregular frequency of exchanges upto 7 days.

The present findings are also in accordance with the findings of Ganesh et al. (1981), Thornhill et al. (1984), Fox et al. (1987), Crisp et al. (1989), Clement et al. (1993), Jankisz et al. (2004) and Kalinbacak et al. (2005) who observed reduction in BUN levels after peritoneal dialysis in renal failure cases.

Serum creatinine (mg/dl) :

(A) Conservative treatment group (T1, T2 and T3) :

In the present study, mean serum creatinine revealed significant difference among groups and treatment intervals.

Under dopamine group (T1), serum creatinine levels (mg/dl) declined significantly (P<0.01) on 3rd (3.37±0.26), 6th (2.45±0.23) and 9th (1.93±0.08) day post treatment as compared to 0 day value (4.09±0.22). This might be due to diuretic effect of dopamine therapy. These findings were in conformity with that of Kapoor et al. (1996), Varriale and Mossavi
(1997) who observed reduction in serum creatinine levels in dopamine treated group as compared to control group in human patients.

Ichai et al. (2000) observed that the low dose dopamine infusion did increase creatinine clearance and urine sodium excretion in critically ill patient with nonoliguric renal impairment.

Our findings are also in accordance with Lane et al. (1994), Labato (2001), Chew et al. (2002), Kraje (2002) and Cowgill and Francy (2005) who also reported diuretic effect of dopamine therapy in acute renal failure cases.

Similarly, under furosemide group (T2), serum creatinine levels (mg/dl) declined significantly ($P<0.01$) on 3rd (3.27±0.26), 6th (2.39±0.23) and 9th (1.85±0.04) day post treatment as compared to “0” day value (4.13±0.20). This might be due to diuretic effects of furosemide. Similar finding was also observed by Shivakumar (2001) who also recorded reduction on serum creatinine levels on 3rd and 7th day as compared to “0” day value in 4 out of 8 cases of acute renal failure in dogs.

While, under dopamine and furosemide group (T3), serum creatinine levels (mg/dl) declined significantly (P<0.01) on 3\textsuperscript{rd} (2.26±0.10), 6\textsuperscript{th} (1.67±0.23) and 9\textsuperscript{th} (1.50±0.20) day of post treatment as compared to “0” day value (4.30±0.18). This might be due to synergistic effects of dopamine and furosemide. Furosemide increases renal blood flow through activation of renal prostaglandin system and dopamine also enhances the renal blood flow by vasodilation, thereby causing an increase in urine production (Grauer and Lane, 1995b). Similar findings were also observed by Lindner (1979), Graziani \textit{et al.} (1983), Ihle and Kostolich (1991) and Shivakumar (2001).

Our findings are also in accordance with the findings of Grauer (1989), Grauer and Lane (1995b), Grauer (1998), Lane and Grauer (1994), Labato (2001), Chew \textit{et al.} (2002) and Macentire \textit{et al.} (2005) who also recommended the use of dopamine and furosemide therapy to induce diuresis in acute renal failure cases.

In the present investigation, serum creatinine levels revealed significant variation among groups. Serum creatinine levels of dogs treated with combination of dopamine and furosemide therapy (T3) on 3\textsuperscript{rd} and 6\textsuperscript{th} post treatment day were significantly lower (2.26±0.10 and 1.67±0.26) than those treated with dopamine (T1) and furosemide (T2) separately and the values recorded on 3\textsuperscript{rd} and 6\textsuperscript{th} day were 3.37±0.26 and 2.45±0.23 in T1 group and 3.27±0.26 and 2.39±0.23 in T2 group, respectively.
These results revealed maximum reduction in serum creatinine levels among dogs treated with combination of dopamine and furosemide (T3) right from 3rd post treatment day indicating that, a combination of dopamine and furosemide had better results as compared to dopamine (T1) and furosemide (T2) separately, Linder (1979), Graziani et al. (1983). Ihle and Kostolich (1991) and Shivakumar (2001) observed similar findings in acute renal failure cases after treatment.

Srivella et al. (2000) studied post operative acute renal failure cases in human patient, using mannitol, furosemide and dopamine. They observed that infusion of these drugs promoted diuresis in patient with acute post operative renal failure with adequate post operative cardiac output. They also reported that early administration of above solution in acute renal failure caused early restoration of renal function to normal.

Brant et al. (2001) studied ARF associated with ingestion of grapes or raisins in 10 dogs, using furosemide, dopamine and mannitol. Four dogs recovered completely with aggressive treatment of these drugs.

(C) Dialytic treatment group (T4 and T5):

In the present investigation, mean serum creatinine levels revealed significant variation between groups and treatment intervals.
Under peritoneal dialysis twice daily (T4) serum creatinine levels (mg/dl) declined significantly (P<0.05) on 3\textsuperscript{rd} (3.10±0.16), 6\textsuperscript{th} (1.99±0.11) and 9\textsuperscript{th} (1.80±0.06) day of post-treatment as compared to "0" day value (7.07±0.43). Similarly, under peritoneal dialysis four times daily (T5) serum creatinine levels (mg/dl) declined significantly (P<0.01) on 3\textsuperscript{rd} (1.89±0.42), 6\textsuperscript{th} (1.32±0.20) and 9\textsuperscript{th} (1.32±0.16) day of post treatment as compared to "0" day value (7.33±0.72). However, in between experimental group (T4 and T5), serum creatinine levels revealed significant (P<0.05) variations. Serum creatinine level of dogs treated with peritoneal dialysis 4 times daily (T5) on 3\textsuperscript{rd}, 6\textsuperscript{th} and 9\textsuperscript{th} day post treatment were significantly lower as compared to peritoneal dialysis twice daily.

These results revealed maximum reduction in serum creatinine levels among dogs treated with peritoneal dialysis 4 times daily right from 3\textsuperscript{rd} post treatment day indicating that, peritoneal dialysis 4 times daily had better results as compared to peritoneal dialysis twice daily. Similar findings were observed by Dighe et al. (1990) who found significant declined in mean values of serum creatinine from 5.82 to 3.53 mg/dl in dogs in which dialysis was done once daily and from 4.95 to 2.74 mg/dl in which dialysis was done twice daily for 4 days.

Mahajan (2000) observed the value of serum creatinine from 8 to 1.8 mg/dl after 3rd day of dialysis with 8 consecutive exchanges per day. Where as Jackson (1964) observed reduction of serum creatinine
value from 5.13 to 1.52 mg/dl after 10 exchanges with a irregular frequency of exchanges upto 7 days.

Our findings are also concordance with the finding of Ganesh et al. (1981), Thornhill et al. (1984), Fox et al. (1987), Crisp et al. (1989), Clement et al. (1993), Jonkisz et al. (2004) and Kalinbacak et al. (2005) who observed reduction in serum creatinine levels after peritoneal dialysis in acute renal failure cases.

Total serum protein (TSP) :

(A) Conservative treatment group (T1, T2 and T3) :

In the present investigation, TSP levels revealed non-significant difference among groups and treatment intervals. Even though proteinuria was observed in 6 out of 12 cases of acute renal failure, there was no clinical signs of hypo proteinemia in any of the ARF dog. The present finding on TSP values agree with Clement et al. (1993) who recorded no appreciable changes in serum protein in experimentally induced ARF in dogs.

Thrall et al. (1984) recorded the levels of total serum protein in 23 ARF dogs. They found 8 dogs had increased total serum protein while remaining 15 dogs were in the normal reference range. Shivakumar (2001) found non-significant changes in the total protein between normal and ARF dogs.
Dialytic treatment group (T4 and T5):

In the present study, TSP levels revealed non-significant variation between experimental groups (T4 and T5) but significant reduction (P<0.05) was seen within group in T5 while, non-significant reduction was observed in T4 group.

Under peritoneal dialysis 4 times daily (T5), TSP levels declined significantly on 3rd day but the differences among 3rd, 6th and 9th day were non-significant. The reduction in total serum protein might be due to gastrointestinal loss of protein and proteinuria.

Protein loss has been reported to develop in all human patient undergoing peritoneal dialysis (Ribot et al., 1966). Protein losses can be variable and it would be from 40 to 50 g/dialytic treatment to approximately 10 g/dialysis depending upon the condition of the dialysis (Crisp et al., 1989).

Crisp et al. (1989) and Kalinbacak et al. (2005) observed that protein losses are the higher during the first few exchange and then tend to stablize. They also reported that albumin losses is more severe than that of globulin.

The present findings are also concordance with Osborne et al. (1972), Thornhill et al. (1984), Carter et al. (1994), Dzyban (2000) and Chew et al., (2000) who also reported loss of body protein into effluent dialysate during peritoneal dialysis.
Serum Albumin (A), Globulin (G) and Albumin-Globulin ratio (A:G):

(a) Conservative treatment groups (T1, T2 and T3):

In the present study, mean serum albumin, serum globulin and albumin-globulin ratio revealed non-significant variation among groups and treatment intervals, although proteinuria was observed in 6 out of 12 cases of acute renal failure. The present findings agree with Clement et al. (1993) who also recorded no appreciable change in serum protein in experimentally induced ARF in dogs.

Kalinbacak et al. (2005) observed non-significant variation in the level of total protein and albumin between normal and ARF cases.

(b) Dialytic treatment group (T4 and T5):

In the present study, mean serum albumin levels revealed non-significant variation between groups but significant reduction (P<0.05) was seen within group in T5 while, non-significant reduction was observed in T4 group.

Under peritoneal dialysis 4 times daily (T5), mean serum albumin levels declined significantly on 3rd day but the differences among 3rd, 6th and 9th day were non-significant. The reduction in serum albumin levels might be due to gastrointestinal loss of albumin and albuminuria. Similar findings were reported by Osborne et al. (1972), Thornhill et al. (1984), Crisp et al. (1989), Carter et al. (1994), Chew et al. (2000), Labato (2001) and Kalinbacak et al. (2005).
Also, mean serum globulin and mean albumin-globulin ratio revealed non-significant variation between groups and treatment intervals; although albumin-globulin ratio were lower on 3rd, 6th and 9th day post-treatment as compared to 0 day value in both T4 and T5 groups. This reduction of A:G ratio might be due to gastrointestinal loss of albumin and albuminuria.


**Serum sodium (Na):**

In the present investigation, mean serum sodium levels revealed non-significant variation among groups and treatment intervals in conservative group. Similarly in dialytic group, mean serum sodium levels showed non-significant difference between groups and treatment intervals. The present findings are in conformity with Shivakumar (2001) who also observed non-significant changes on mean serum sodium levels after treatment in clinical cases of ARF in dogs.

Thrall *et al.* (1984) reported that serum sodium levels usually normal in ARF cases in dogs. However, a mild to moderate hypernatremia was a consistent finding in majority of the dogs. 11 out of 21 ARF cases had serum sodium levels more than 145 mEq/L with a mean
of 151.35±1.28 Meq/L. Serum sodium concentration in ARF cases can be normal, low or elevated depending upon the factors contributing to patient dehydration and the stage of disease process, abnormalities in the sodium and water balance are the results of their continued ingestion in presence of decreased excretory function (Mary, 1992). However, the higher sodium values noticed in the present study may be because of reduction in the renal blood flow and glomerular filtration rate (David and Carl, 1995).

Hypernatremia may result when the loss of free water exceeds sodium loss (Stanley, 1995, Mary, 1992). Hypernatremia sometimes occurs in patients with non-oliguric renal failure, especially where, they received high sodium osmolar load (Arthur, 1982).

Serum potassium (K) :

In the present investigation, mean serum potassium levels revealed non-significant variation among groups and treatment intervals in conservative group. Similarly, in dialytic group serum potassium levels showed non-significant difference between groups and treatment intervals. The present findings are in conformity with Shivakumar (2001) who also observed non-significant changes on serum potassium levels after treatment in clinical cases of ARF in dogs.

Vaden (2000) reported that serum potassium levels in ARF cases can be normal or hyperkalemic. Accordingly in the present study
hyperkalemia were observed in 6 out of 21 ARF cases with a mean of 5.72±0.18 mEq/L. Hyperkalemia is a characteristic feature in ARF cases (Thrall et al., 1984; Shahar and Holmberg, 1985; Grauer, 1989; Mary, 1992; Stanley, 1995; Jayathangaraj et al., 1995 and Labato, 2001). Hyperkalemia is a frequent complication of ARF resulting from decreased urinary excretion, metabolic acidosis, tissue injury, haemolysis and increased tissue catabolism (Mary, 1992).


Urine analysis observations :

Urine specific gravity (USG):

In the present investigation, mean USG revealed non-significant variation among groups and treatment intervals in conservative group. Similarly in dialytic group mean USG showed non-significant difference between groups and treatment intervals.

However, isosthenuria or little concentrated urine with a mean specific gravity 1.0168±0.079 were observed in ARF cases. This

Tyler et al. (1987) reported a low specific gravity (<1.030) in dogs when dehydrated and/or azotemic which had reduced renal concentrating ability and the most common cause being renal failure.

Urine pH and Colour:

In the present study, mean urine pH revealed non-significant variation among groups and treatment intervals in conservative group. Similarly, in dialytic group, mean urine pH showed non-significant difference between groups and treatment intervals. However the mean urine pH was found within the normal reference range in all the treated groups.

Rani (2004) noticed non-significant difference in the urine pH value of renal failure cases and healthy control group.
The colour of urine varied between straw yellow to oily yellow. Ganesh et al. (1981) and Rani (2004) observed similar findings in renal failure cases in dogs.

Proteinuria and sediments:

Routine analysis of urine revealed proteinuria ranging from distinct narrow ring (+) to very wide ring (+++) in 14 acute renal failure cases. Further, the microscopic examination of urine sediments revealed the presence of WBC, RBC, WBC cast, granular cast, hyaline cast, renal epithelial cells, transitional epithelial cells and squamous epithelial cells in variable numbers in individual dog under both conservative and dialytic treatment groups. Proteinuria with sediments is indicative of ARF (Lane et al., 1994, Mary, 1992 and Grauer, 1989) and early tubular damage (Lane et al., 1994, Grauer and Lane, 1995b). Proteinuria with increased urinary sediments was noticed in ARF dogs by Ganesh et al. (1981), Scott et al. (1985), Garry et al. (1990), Dighe et al. (1990), Clement et al. (1993), Jayathangaraj et al. (1995) and Mahajan (2000).

After conservative and dialytic treatment proteinuria was either absent or present to a distinct narrow ring (+) on ninth day of experiment. The microscopic examination of urinary sediments revealed absence or reduction in the number of casts and cells. This indicated that functioning of nephrons were returning back to normal. Similar results were obtained by Ganesh et al. (1981) and Dighe et al. (1990) who
observed either absence or present to a narrow distinct ring (+) of proteinuria and absence or reduction in the number of cast and cells.

Healthy Control (T6):

A total of 5 healthy dogs were selected to establish normal values. Dogs were selected based on clinico-haematobiochemical and urine analysis examination.

Clinical observation:

In the present investigation, mean values of temperature, respiratory and pulse rate were 101.4±0.14°F, 22.2±0.8 (per minute) and 92±0.70 (per minute), respectively. Similar findings were reported by earlier workers (Singh et al., 2004; Chakrabarti, 2006).

Haematological observations:

In the present study, mean values of Haemoglobin (Hb), Packed Cell Volume (PCV), Total Erythrocyte Count (TEC), Total Leucocyte Count (TLC), Neutrophil count (%), Lymphocyte count (%), Monocyte count (%) and Eosinophil count (%) were 12.8±0.34 g/dl, 39.68±1.14%, 5.93±0.34x10⁶/µl 9.53±0.75 x 10³/µl, 62.2±1.16%, 27.4±1.80%, 3.4±0.68% and 3±0.55%, respectively. These haematological parameters were within the normal ranges which is similar
Biochemical observations:

In the present investigation, mean values of Blood urea nitrogen, serum creatinine, total serum protein, albumin, globulin, A:G ratio, sodium and potassium were 19.24±0.85 mg/dl, 0.96±0.09, 6.61±0.13 g/dl, 3.41±0.13 g/dl, 3.20±0.11 g/dl, 1.07±11, 138.4±1.35 mEq/L and 4.20±0.15 mEq/L, respectively. These biochemical parameters were within the normal range which is similar to the observations reported by earlier workers (Coles, 1974, Willard et al., 1994, Osborne et al., 1972 and Benzamin, 2005).

Urine analysis observations:

Urine analysis was performed immediately after collection of samples. The specific gravity reflects the ability of the kidney to either concentrate or dilute the urine. The mean specific gravity in the present study (1.0184±0.002) was within the normal range described by earlier workers (Coles, 1974; Willard et al., 1994, Osborne et al., 1995, Finco, 1997 and Benzamin, 2005).

In the present study, the mean urine pH of group T6 was 5.8±0.37. The pH of urine provides a reflection of the metabolic state of
the body. These values are similar to the range given by Coles, 1974; Willard et al., 1994, Osborne et al., 1995 and Benzamine, 2005.

The quantitative analysis of urine for colour, presence of albumin and sediments examination showed no abnormality to indicate the disease status of the kidney. The colour of the urine varied between straw yellow to oily yellow. Similar findings were reported by Coles, 1974, Willard et al., 1994, Osborne et al., 1995, and Benzamine, 2005).