

## Diseases and Outcomes in Rabbits with High BUN Levels

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**ABSTRACT.** One hundred and ninety cases of rabbits, seen at animal hospitals in Saitama and Tokyo, Japan from 1998 to 2001, with BUN values greater than 27 mg/dl were analyzed regarding their underlying and/or complicating diseases and outcomes. Gastrointestinal disorder (54 cases) was the most common disease, followed by overgrowth of molar teeth and then liver disturbance. The total mortality was 48.9% within three months, and cases showing complications such as liver disturbance or bacterial infection showed highest mortality. Cases with higher BUN values showed even higher mortality, although mortality varied depending on the complications. Therefore, the prognosis of rabbit cases with high BUN values should be evaluated based on findings from blood chemistry, together with the seriousness of the underlying and/or complicating disease.

**KEY WORDS:** BUN, mortality, rabbit.

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BUN values are frequently examined to diagnose clinical disorders in rabbits [3, 9], as well as in dogs and cats. Though high BUN levels have been reported in laboratory rabbits in experimental surveys of nephrotoxicity [1, 2, 6, 8, 14] or models of renal dysfunction [4, 7, 13], BUN values in companion rabbits have not been well studied. Cases of companion rabbits with high BUN values were analyzed regarding the underlying or complicating diseases and the outcomes.

A total of one hundred and ninety cases of rabbits, with BUN values greater than 27 mg/dl, were examined at Saito Animal Hospital (Saitama-shi, Saitama, Japan) and Saito Rabbit Clinic (Kita-ku, Tokyo, Japan) from 1998 to 2001. Serum creatinine was also checked in all of these cases. From the results of an investigation of 111 healthy rabbits [10], BUN values greater than 27 mg/dl and serum creatinine values greater than 1.4 mg/dl were regarded as abnormal values in this study.

These cases did not show any common signs, aside from anorexia. Various degrees of anorexia were observed in 181 of 190 cases (95.3%). Depression was noted in 42 cases (22.1%), diarrhea in 37 cases (19.5%), and dehydration in 30 cases (15.8%). The ages ranged from two months to eleven years of age, with a median of 3.5 years and a standard deviation of 2.4 years. One hundred and four cases (54.7%) were males and 86 cases (45.3%) were females. Blood samples were taken from the cephalic vein, intermedial branch of the caudal auricular artery, external saphena, or external thoracic vein. In several cases, blood samples were taken from more than one site, and the site of blood collection was confirmed not to influence BUN values. BUN levels were analyzed by VetScan (Daiichi Pure Chemicals Co., Ltd.) or VetTest (IDEXX Laboratories, KK).

Each rabbit was managed according to its specific condition by removing inducing factors, treating complications, and improving renal function. Fluid therapy was administered, mainly intravenously and sometimes subcutaneously,

in 175 cases, and force-feeding was carried out in 71 cases. Antibiotics and/or other medications were administered in 188 cases.

For analyzing mortality, cases in the three month period after the first medical examination were divided into recoveries and deaths. Among 190 cases, 97 (51.1%) were alive three months after the first medical examination and had recovered. On the other hand, 93 (48.9%) had died within three months. The deaths within the first three months occurred within a range from 0 to 89 days (median 9 days, standard deviation 17.3 days). The relationship between the range of BUN values and the mortality rate is shown in Fig. 1, which demonstrates that cases with higher BUN values clearly show higher mortality ( $r=0.928$ ).

The mortalities for each age were 50% (8 out of 16) in rabbits less than 1 year old, 68.0% (17 out of 25) in 1 year olds, 46.7% (14 out of 30) in 2 year olds, 59.4% (19 out of 32) in 3 year olds, 46.9% (15 out of 32) in 4 year olds, 50.0% (10 out of 20) in 5 year olds, 50.0% (4 out of 8) in 6 year olds, 35.7% (5 out of 14) in 7 year olds, and 42.9% (3 out of 7) in 8 year olds.

The relationship between underlying and/or complicating disease and the outcome is shown in Fig. 2. The total number of cases exceeded 190, because some rabbits had more than one disease. Eighteen cases with no complications only showed abnormal renal function and relevant symptoms. Gastrointestinal disorder (54 cases) and overgrowth of molar teeth (35 cases) were most common followed by liver disturbance (20 cases), lithiasis in the lower urinary tract (19 cases), bacterial infection (14 cases), uterine disorder (13 cases), neurological disorder (12 cases), husbandry failure (11 cases), and adverse effects of anesthesia (10 cases).

Cases of bacterial infection, liver disturbance, and husbandry failure showed highest mortality (78.6%, 70.0%, and 63.6% respectively). The lowest mortality was seen in lithiasis in the lower urinary tract (21.1%), followed by over-

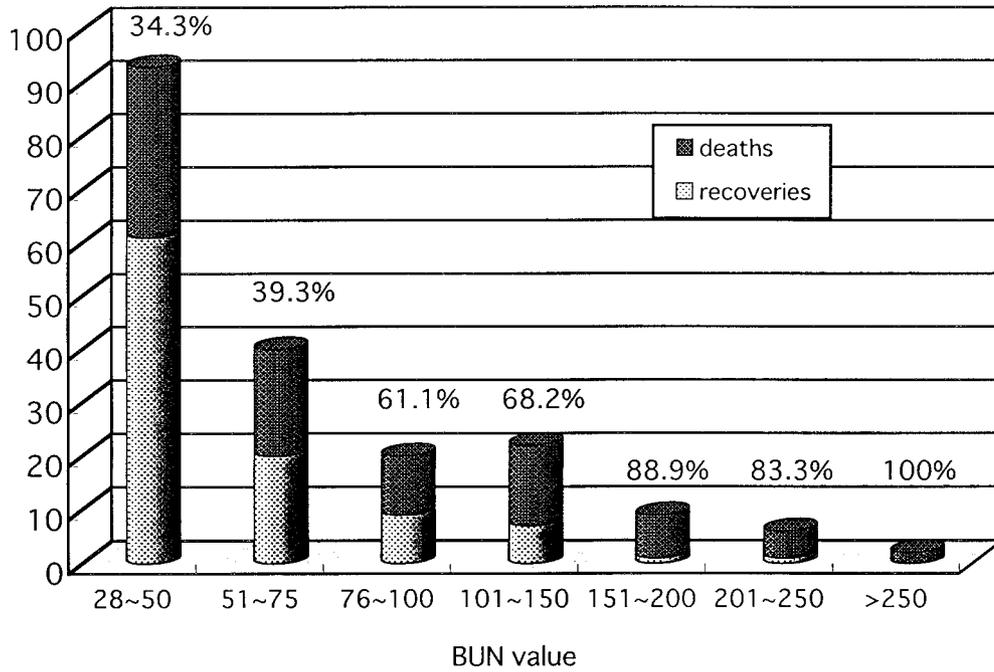


Fig. 1. BUN values and mortality. The horizontal axis indicates the range of BUN values and the vertical axis denotes the number of cases. Each column is divided into deaths and recoveries, as shown by different shades. The figure on the top of each column shows mortality within each BUN range.

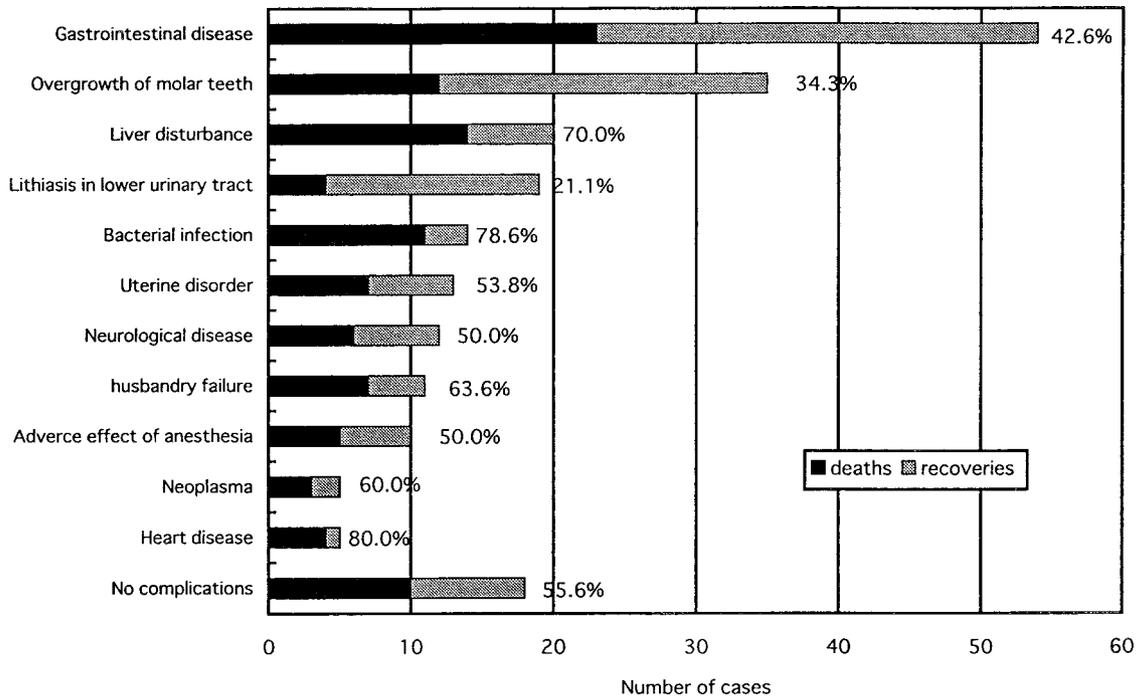


Fig. 2. The underlying or complicating diseases and outcomes. 18 cases showed no complications. Gastrointestinal disorder was the most common complication, followed by overgrowth of molar teeth, and liver disturbance. The percentage indicates the mortality for each group.

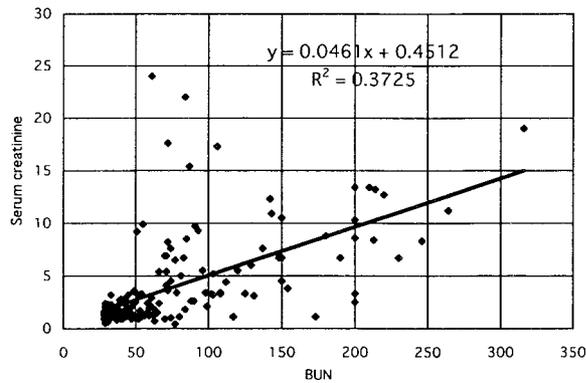


Fig. 3. Correlation between BUN and serum creatinine. The BUN and serum creatinine values are plotted for all 190 cases.

growth of molar teeth (34.3%).

One hundred and thirty one (68.9%) out of 190 cases with high BUN values showed elevated serum creatinine greater than 1.4 mg/dl, and the rest of the cases (59 cases, 31.1%) showed normal creatinine values, less than 1.4 mg/dl. The correlation between BUN values and serum creatinine values was low ( $r=0.61$ ) (Fig. 3).

The greatest number of cases was in 1 to 4 year olds, with the peak in 3 and 4 year olds. This may be due to the fact that rabbits brought to animal hospitals tend to be younger [11], and therefore, may not necessarily suggest that renal disturbance is prone to occur in rabbits less than 5 years of age. No relationship between age and mortality was observed. Further study, however, may be necessary because the number of older rabbits was not sufficient for analysis. Among young rabbits under 1 year of age, with elevated BUN values (16 cases), 8 rabbits died, the majority of which (6 cases) suffered from gastrointestinal disorder.

As shown in Fig. 2, many types of underlying and/or complicating diseases were seen, with greatly varying mortalities. The complications with the lowest mortality were lithiasis in the lower urinary tract (21.1%), followed by overgrowth of molar teeth (34.3%). The mortality due to these complications might be low because such diseases can be treated rather easily. On the other hand, mortality was high in rabbits with bacterial infection (78.6%), liver disturbance (70.0%), and husbandry failure (63.6%), and therefore, the prognoses of these diseases, when accompanied by high BUN levels, should be guarded.

The frequency of gastrointestinal disorders such as trichobezoars and stasis are very high [11]. In these cases, increased BUN might occur following long-term anorexia, and in some cases, renal disturbance might induce gastrointestinal disorders. Overgrowth of molar teeth was also observed with very high incidence [11], and in many of these cases, anorexia and lack of water intake might lead to abnormal BUN values.

The reason for the high mortality in cases of liver disturbance (85.0%) might be explained by several factors. The prognosis of liver disturbance is usually poor because over-

weight rabbits tend to develop irreversible hepatic lipidosis [3,5] and kidney cell degeneration [9]. Evaluation of liver and renal function is important, because overweight in household rabbits is not uncommon these days.

The incidence of lithiasis in the lower urinary tract was comparatively high, probably because urinary calculus can frequently obstruct the urinary tract and induce postrenal renal failure. The mortality of lithiasis in the lower urinary tract was probably the lowest (21.1%) because rabbits can recover relatively rapidly with appropriate therapy.

Cases of bacterial infection, such as abscesses accompanied by increased BUN, also occurred with comparatively high incidence. In such cases, the pathogenic bacteria were probably transported to the kidney via blood flow and might thereby cause nephritis. The mortality of these bacterial infections was high (78.6%), perhaps due to difficulty in controlling bacterial infection and advanced renal failure.

Uterine disorders, including endometrial hyperplasia and uterine adenocarcinoma, are common diseases, and mortality tends to be low with adequate surgical management [12]. Cases accompanied by high BUN values, however, sometimes resulted in poor outcome. In those cases, dystosia proceeded into prolonged gestation or uterine rupture, frequently associated with renal failure and death.

Neurological disorders included torticollis and hindquarter paralysis. An inability to drink water might trigger the abnormal renal function in the cases of torticollis, and an inability to urinate might lead to postrenal renal failure in the cases of hindquarter paralysis.

The most important husbandry failure resulted from insufficient water supply to the rabbits. Abnormal renal function was thought to typically advance chronically in these cases, and consequently, the survival rate was low.

In cases of adverse effects of anesthesia, even rabbits with mostly normal BUN and creatinine levels before surgery, showed drastically abnormal levels afterwards. Therefore, it might be very important to maintain renal blood flow during anesthesia and to monitor BUN values after surgery.

In this study, BUN and serum creatinine values were not closely correlated. Underlying and/or complicating diseases might explain the lack of correlation, and further investigation is necessary to prove this. The results of this study suggest that the prognosis in rabbits with high BUN values should be evaluated based on the findings from blood chemistry, together with the seriousness of the underlying and/or complicating diseases.

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