

CHARACTERISTICS OF CHEMICAL URINALYSIS AND URINE SEDIMENT EXAMINATION IN CHRONIC KIDNEY DISEASE PATIENTS AT PROF. DR. I.G.N.G. NGOERAH GENERAL HOSPITAL IN 2024

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ABSTRACT

Background: Chronic Kidney Disease (CKD) is characterized by irreversible decline in kidney function and alterations in urine composition. Data regarding urinalysis profiles among CKD patients at Prof. Dr. I.G.N.G. Ngoerah General Hospital remain limited. This study aimed to determine the characteristics of chemical urinalysis and urine sediment in CKD patients.

Methods: This descriptive analytic observational study used a cross-sectional design. A total of 76 CKD patients who met the inclusion criteria from January to March 2024 were included using total sampling. Data were obtained from medical records and analyzed using SPSS version 29.0.

Results: Most patients were male (56.6%), aged 56–65 years (43.4%), and had advanced-stage CKD (stages IV and V). Chemical urinalysis showed normal specific gravity in 98.7% of patients and a median urine pH of 5.5. Abnormal findings were dominated by positive leukocyte esterase (51.3%) and proteinuria (38.2%). Urine sediment examination showed median erythrocytes of 2/HPF and leukocytes of 9/HPF, with bacteriuria found in 80.3% of patients. Granular casts were detected in 18.4%, while pathological crystals were found in small proportions.

Conclusion: Urinalysis findings in CKD patients were predominantly characterized by leukocyte esterase positivity, proteinuria, and bacteriuria, suggesting accompanying inflammation or infection and advanced kidney damage.

Keywords: chronic kidney disease, urinalysis, urine sediment

INTRODUCTION

Chronic Kidney Disease (CKD) is defined as a pathophysiological condition characterized by structural or functional abnormalities of the kidney lasting more than three months.¹ This condition manifests as kidney pathological abnormalities or markers of kidney damage, including abnormalities in blood or urine composition, as well as a decrease in Glomerular Filtration Rate (GFR) to below 60 mL/min/1.73 m².² This disease has developed into a global public health problem with an increasing disease burden in line with the epidemiological transition towards non-communicable diseases.^{2, 3} Pathophysiologically, CKD is characterized by progressive and irreversible destruction

of nephrons, where the kidneys slowly lose their ability to maintain fluid, electrolyte, and metabolic waste balance.⁴

In Indonesia, the increasing trend of CKD cases is a serious concern for the national health system. Based on national data, the prevalence of chronic kidney disease in Indonesia is recorded at 0.38%, a figure showing a significant increase compared to previous years.⁵ This increase in prevalence is strongly correlated with the high incidence of major risk factors in the community, namely uncontrolled diabetes mellitus and hypertension.³ This condition demands strict early detection and clinical monitoring strategies to prevent patients from falling into End-Stage Renal Disease (ESRD) requiring lifelong renal replacement therapy.

One of the main and fundamental diagnostic modalities in

the evaluation of kidney disease is urinalysis.⁶ Urinalysis is often referred to in medical literature as a "liquid kidney biopsy" because of its ability to provide in-depth and real-time information regarding the condition of the renal parenchyma without requiring invasive action.⁷ This examination consists of three main evaluation stages: macroscopic examination, chemical urine examination, and microscopic urine sediment examination.⁸

Chemical urine examination plays a vital role in detecting functional kidney abnormalities, especially proteinuria as a highly sensitive early marker of glomerular filtration barrier damage.⁹ Additionally, leukocyte esterase and nitrite parameters can be indicators of inflammatory processes or urinary tract infections, which are comorbidities often accompanying CKD patients due to decreased immune systems.¹⁰ On the other

hand, microscopic examination of urine sediment provides direct visualization of cellular elements released into the urine.¹¹ Identification of pathological elements such as casts, dysmorphic erythrocytes, and abnormal crystals is very helpful for clinicians in determining the specific etiology of kidney disease, whether originating from glomerular, tubular, or interstitial abnormalities.¹¹

Prof. Dr. I.G.N.G. Ngoerah General Hospital handles a very high volume of CKD patients with a varied spectrum of disease severity.¹² Although urinalysis is a routine procedure, comprehensive data mapping the characteristics of chemical urinalysis and sediment results specifically in the CKD patient population at this hospital has not been widely published. Mapping these characteristics is very important to determine the dominant pattern of abnormalities, so as to increase clinician awareness of certain complications, such as asymptomatic urinary tract infections or tubular damage progression.¹³

Based on the aforementioned background, this study aims to determine the characteristics of chemical urinalysis and urine sediment examination in Chronic Kidney Disease patients at Prof. Dr. I.G.N.G. Ngoerah General Hospital. Specifically, this study aims to describe the distribution of chemical urinalysis parameters and microscopic urine sediment findings among CKD patients. Hopefully, the data obtained from this study can serve as a valid basic reference in daily clinical management.

OBJECT AND METHOD

This study was designed as a descriptive analytic observational study using a cross-sectional approach. This approach was chosen because the researcher measured or observed independent and dependent variable data only once at the same time. The main objective of this design was to provide an objective overview of the frequency distribution and characteristics of the variables studied without intervening or treating the research subjects.

The study was conducted at the Medical Record Installation of Prof. Dr. I.G.N.G. Ngoerah General Hospital, Denpasar.

The data collection process lasted for a period of three months, starting from January to March 2024. The selection of the research location was based on the consideration that Prof. Dr. I.G.N.G. Ngoerah General Hospital was a tertiary referral center that had complete patient medical record data and standardized and accredited clinical pathology laboratory facilities, so that the validity of laboratory result data could be accounted for. The target population in this study covered all patients diagnosed with Chronic Kidney Disease (CKD) by the attending physician. The sampling technique applied was total sampling, which was a sampling technique by taking all population members who met the established inclusion and exclusion criteria. Inclusion criteria included: (1) Patients diagnosed with CKD recorded in medical records; and (2) Patients who had complete urinalysis laboratory examination results, including chemical urine parameters and microscopic urine sediment, during the study period. Meanwhile, exclusion criteria were medical records with incomplete, damaged, or illegible data making data extraction impossible. Based on these criteria, a total sample of 76 patients was obtained and included in the analysis.

Variables assessed in this study were grouped into two main categories, namely demographic characteristics and laboratory characteristics. Demographic characteristics included age (grouped based on standard Ministry of Health categories), gender, and CKD stage classified based on Glomerular Filtration Rate (GFR) values into Stages I to V. Laboratory characteristics included chemical urinalysis parameters (pH, specific gravity, leukocyte esterase, nitrite, protein, glucose, ketone, urobilinogen, bilirubin, and blood/hemoglobin) and urine sediment parameters (erythrocyte count, leukocyte count, epithelial cells, presence of casts, crystals, bacteria, and yeast).

Data were analyzed univariately using SPSS (Statistical Package for the Social Sciences) software version 29.0 and presented in the form of frequency distribution tables and descriptive narratives. Ethical clearance was obtained from the Research Ethics Committee of the Faculty of Medicine, Udayana University (Ethical Clearance No. 0685/UN14.2.2.VII.14/LT/2025).

RESULT

Characteristics of Subject Based on Age, Gender, Disease Stage, and e-GFR

Based on the results of medical record tracking of 76 CKD patients who were research subjects, varied demographic characteristics were obtained as presented in Table 1. The majority of patients were male, totaling 43 people (56.6%), while female patients totaled 33 people (43.4%). This ratio indicated a tendency for male dominance in the CKD sufferer population at the study location. In terms of age, patient distribution ranged from young adults to the elderly. Table 1 showed that the age group with the highest frequency was found in the late elderly category (56–65 years) with 33 patients (43.4%), followed by the early elderly

category (46– 55 years) with 18 patients (23.7%). These findings indicated that CKD prevalence increased with age.

Table 1. Characteristics subject based on age, gender, disease stage, and e-GFR

Variable	n (%)	Mean $\pm$ SD	Median (min – max)	Modus
Age (year)		57,03 $\pm$ 12,849		57
Late adolescence	2 (2,6)			
Early adulthood	2 (2,6)			
Late adulthood	6 (7,9)			
Early old age	24 (31,6)			
Late old age	33 (43,4)			
Elderly	9 (11,8)			
Sex				
Male	43 (56,6)			
Female	33 (43,4)			
CKD stages				
Stage I	1 (1,3)			
Stage II	5 (6,6)			
Stage IIIa	11 (14,5)			
Stage IIIb	10 (13,2)			
Variable	n (%)	Mean $\pm$ SD	Median (min – max)	Modus
Stage IV	25 (32,9)			
Stage V	24 (31,6)			
GFR category			22,5 $\pm$ (2,22 – 90,41)	12,84
≥ 90	1 (1,3)			
60–89	5 (6,6)			
45–59	11 (14,5)			
30–44	10 (13,2)			
15–29	25 (32,9)			
<15	24 (31,6)			
Total	76 (100)			

Furthermore, data in Table 1 revealed that based on disease severity or clinical stage, the majority of research subjects were in advanced stages of chronic kidney disease. A total of 25 patients (32.9%) were diagnosed with CKD Stage IV, and 24 patients (31.6%) were in CKD Stage V (end-stage renal disease). Only a small proportion of patients were detected in early stages (Stage I and II), which was likely due to the asymptomatic nature of this disease in the initial phase, so patients often only sought medical help when the disease was progressive. Characteristics of Subject Based on Chemical Urinalysis .The results of chemical urine examination using the dipstick method provided a diverse picture of patient urine biochemical profiles, which were summarized in Table 2. Almost all patients (98.7%) had urine specific gravity within the normal range (1.003 – 1.030), indicating that urine concentration ability in most patients was still relatively maintained in this parameter

or influenced by hydration status during examination. Urine acidity (pH) had a median value of 5.5 with a range of 4.5 to 8.0, meaning most patients had acidic (physiological) urine. As detailed in Table 2, proteinuria, as the main marker of glomerular leakage, was found positive in 29 patients (38.2%). Findings of blood or hemoglobin in urine were detected positive in 30 patients (39.5%), which could indicate microscopic hematuria due to nephron damage. The leukocyte esterase parameter showed the highest abnormal results, with positive results in 39 patients (51.3%), leading to suspicion of urinary tract inflammation. However, the nitrite parameter specific for nitrate- reducing bacteria was only positive in 8 patients (10.5%). Additionally, glycosuria was found in 13 patients (17.1%), which was likely related to diabetes mellitus comorbidities suffered by patients. Ketones, bilirubin, and urobilinogen were found positive in very small percentages (<5%).

Table 2. Characteristics of subject based on chemical urinalysis results

Variable	n (%)	Mean $\pm$ SD	Median (min – max)	Modus
Urine specific gravity		1,015 $\pm$ 0,0069		1,010
Normal	75 (98,7)			
High	1 (1,3)			
Urine pH			5,50 (5,00 – 8,50)	5,50
4,5 < pH < 8	75 (98,7)			
pH > 8	1 (1,3)			
Leukocyte esterase				
Negative	37 (48,7)			
Positive (+)	7 (9,2)			
Positive (++)	17 (14,5)			
Positive (+++)	1 (1,3)			
Positive (++++)	14 (18,4)			
Variable	n (%)	Mean $\pm$ SD	Median (min – max)	Modus
Nitrite				
Negative	71 (93,4)			
Positive	5 (6,6)			
Protein				
Negative	26 (34,2)			
Positive (+)	29 (38,2)			
Positive (++)	15 (19,7)			
Positive (+++)	2 (2,6)			
Positive (++++)	4 (5,3)			
Glucose				
Negative	67 (88,2)			
Positive (+)	4 (5,3)			
Positive (++)	2 (2,6)			
Positive (+++)	1 (1,3)			
Positive (++++)	2 (2,6)			
Ketone bodies				
Negative	76 (100)			
Urobilinogen				
Normal	74 (97,4)			
2.0	2 (2,6)			
Bilirubin				
Negative	71 (93,4)			
Positive (+)	3 (3,9)			
Positive (++)	1 (1,3)			
Positive (+++)	1 (1,3)			
Blood/Hb				
Negatif	31 (40,8)			
Positif (+)	7 (9,2)			
Positif (++)	13 (17,1)			
Positif (+++)	25 (32,9)			
Total	76 (100)			

Characteristics of Subject Based on Urine Sediment (Microscopic) Examination Results

Microscopic examination of urine sediment provided an overview of solid elements suspended in urine, as shown in Table 3. The median erythrocyte count was found to be 2 cells/HPF (High Power Field), while the median leukocyte count was 9 cells/HPF. This leukocyte value was at the upper limit of the normal reference value, pointing towards mild pyuria conditions in the average sample population. Epithelial cells were found with a median of 1 cell/HPF. Table 3 also indicated that bacterial findings in urine sediment were

very striking, positive in 61 patients (80.3%). This high rate of bacteriuria was in line with the high finding of leukocyte esterase in chemical examination. Conversely, fungal infection (yeast) was not found significantly (median 0), with only 1 patient showing a positive yeast result. Granular casts, which were markers of tubular damage, were found in 14 patients (18.4%). Other cast types such as hyaline casts were found in minimal amounts. Pathological crystals were relatively rarely found; amorphous crystals were identified in 3.9% of patients, while calcium oxalate and uric acid crystals were each found in 2.6% of patients (2 people)

Table 3. Characteristics of subject based on urine sediment (microscopic) examination results

Variable	n (%)	Mean $\pm$ SD	Median (min – max)	Modus
Erythrocytes			2 (0 – 1.604)	0
Leukocytes			9 (0 – 9.633)	1
Epithelial cells			1 (0 – 45)	0
Bacteria			467,85 (1,1 – 75.316)	10.000
Negative	15 (19,7)			
Positive	61 (80,3)			
Crystals				
Negative	69 (90,8)			
Calcium oxalate	2 (2,6)			
Amorphous	3 (3,9)			
Uric acid	2 (2,6)			
Yeast cells			0 (0 – 3.474,8)	0
Cylindrical				
Negative	62 (81,6)			
Granular	11 (14,5)			
Hyaline	3 (3,9)			
Total	76 (100)			

DISCUSSION

Based on demographic characteristics, this study finds that Chronic Kidney Disease (CKD) patients are predominantly male (56.6%). This finding aligns with the theory stating that men have a higher risk due to lifestyle patterns and the prevalence of comorbidities such as hypertension which are more often uncontrolled compared to women.^{14, 15} In terms of age, the late elderly group (56–65 years) is the largest group. This reflects the degenerative process where kidney function naturally declines with age, aggravated by long-term exposure to chronic diseases.¹⁶ The majority of recorded patients are in stages IV and V, which indicates that patients tend to come to referral health facilities like Prof. Dr. I.G.N.G. Ngoerah General Hospital when the disease is already in an advanced phase requiring renal replacement therapy.^{17, 18}

In chemical urinalysis examination, urine protein parameters show positive results in 38.2% of patients. Proteinuria is a

cardinal marker of glomerular damage.¹⁹ In CKD conditions, the glomerular filtration barrier suffers damage so that proteins which should be reabsorbed leak into the urine. Furthermore, the patients' urine pH has a median of 5.5 (acidic). Acidic urine conditions in CKD patients are often related to metabolic acidosis, where the kidneys lose the ability to excrete the body's acid loads adequately or reabsorb bicarbonate.²⁰ The findings of Urine Specific Gravity (SG) are mostly within the normal range (1.005–1.030), however, this needs to be interpreted with caution because in advanced CKD, isosthenuria (inability to concentrate urine) often occurs, although the patient's hydration factor before sampling also has a significant influence.²¹

The most significant finding in this study is the high positive rate of Leukocyte Esterase (51.3%) and the presence of bacteria in urine sediment (80.3%). This high prevalence of bacteriuria and leukocyturia indicates the susceptibility of CKD patients to Urinary Tract Infections (UTI).^{22–24}

Patients with uremia experience immune system suppression (immunosuppression), so the body's defense response against pathogens decreases. Additionally, decreased urine flow (oliguria) in advanced stages reduces the natural wash-out effect of bacteria from the urinary tract, which facilitates bacterial colonization.²⁰

Microscopic urine sediment examination also shows granular casts in 18.4% of patients. The presence of granular casts is clinically significant because it signals urine stasis in the renal tubules and cellular degeneration, which is often associated with acute tubular necrosis or the progression of the underlying kidney disease.²⁵ Although urine crystals (such as calcium oxalate and uric acid) are only found in a small percentage, their presence remains important because it can reflect mineral metabolism disorders that often accompany CKD or the risk of urinary tract stone formation which can worsen kidney function.²⁶ Squamous epithelial cells are found in most samples, which likely originate from urethral or vaginal contamination during sampling, considering the sampling method is spot urine.²⁷

CONCLUSIONS AND SUGGESTIONS

This study concluded that the characteristics of Chronic Kidney Disease patients at Prof. Dr. I.G.N.G. Ngoerah General Hospital were dominated by males and the late elderly age group, with the majority presenting in advanced stages (IV and V). Chemical urinalysis profiles showed significant abnormalities, particularly proteinuria and positive leukocyte esterase. Furthermore, urine sediment examination revealed a high prevalence of bacteriuria and leukocyturia, which indicated accompanying urinary tract infections, while the presence of granular casts in a subset of patients reflected progressive renal parenchymal damage. Based on these findings, it was suggested that future research utilize a cohort or longitudinal study design to evaluate the causal relationship between kidney disease progression and urine sediment changes more comprehensively. Furthermore, it was recommended to use a larger sample size distributed evenly across disease stages to improve the accuracy of variable correlation analysis. For clinical practitioners, these results highlighted the importance of routine monitoring of leukocyte and bacteria parameters in the urinalysis of CKD patients as an effort for early detection and prevention of urinary tract infection complications.

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