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Difference in creatinine levels before and after hemodialysis in patients with chronic kidney disease

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Abstract

Chronic kidney failure is a progressive condition characterized by a decline in kidney function, leading to an inability to eliminate metabolic waste from the body. Hemodialysis is used as a renal replacement therapy to assist in the blood cleansing process and maintain the patient's physiological balance. This study aims to analyze differences in serum creatinine levels in patients with chronic kidney failure before and after undergoing hemodialysis at the Bali Husada Cipta Canthi Clinic in Denpasar City. The study used an analytical observational design with a cross-sectional approach to 18 patients with end-stage chronic kidney failure, selected through total sampling. Serum creatinine levels were obtained from laboratory tests before and after a single hemodialysis session. The analysis used a paired sample t-test. The results showed a decrease in serum creatinine levels after hemodialysis compared with pre-procedure levels. It indicates the therapy's effectiveness in reducing the accumulation of metabolic waste in the blood. However, post-hemodialysis creatinine levels remained above normal reference values, reflecting the limitations of hemodialysis in entirely replacing kidney function. These findings emphasize the importance of monitoring serum creatinine as a clinical indicator of therapeutic response. Patients with chronic renal failure need to undergo hemodialysis consistently and continuously.

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1. Introduction

The kidneys play an irreplaceable role in maintaining the internal stability of the human body. These organs are responsible for excretion and detoxification, as well as maintaining fluid and electrolyte balance by removing metabolic waste (Aditya et al., 2018). Kidney failure has the potential to cause severe systemic disorders due to fluid and electrolyte imbalances in the body. One form of progressive and long-term kidney disorder is chronic kidney disease (CKD). This condition is characterized by permanent damage to the nephrons, which are the functional units of the kidneys (Mustofa et al., 2022). Damage to kidney tissue reduces kidney mass and triggers compensatory mechanisms, including hypertrophy and hyperfiltration in the remaining functioning nephrons. In the early stages of CKD, renal function reserves begin to decline, even when the glomerular filtration rate (GFR) appears normal or even increases, before eventually progressing to a progressive decline (Afriansya et al., 2020).

The global burden of CKD shows an alarming trend. The 2016 Global Burden of Disease (GBD) report recorded approximately 275.9 million cases of CKD worldwide, including 21.3 million new cases and 1.18 million deaths. This disease ranked 18th among causes of global mortality in 2010 and rose to

11th in 2016 (Sari et al., 2021). In Indonesia, the 2018 Basic Health Research (Riskesdas) results showed a CKD prevalence of 0.38% in people aged ≥15 years, with about 60% of them requiring dialysis therapy. West Java province reported the highest number of cases, followed by East Java and Bali with 12,092 cases (Indonesian Ministry of Health, 2019).

The distribution of CKD is also closely related to age. The highest prevalence is found in the elderly, particularly those aged 65–74 years, and continues to increase with age (Indonesian Ministry of Health, 2019). In advanced stages of CKD, kidney function can no longer be maintained without permanent renal replacement therapy, either through transplantation or hemodialysis. Hemodialysis is the most commonly used therapy in clinical practice to prolong survival in patients with CKD (Mustofa et al., 2022). Although effective, this therapy is not without its impact on quality of life, including sleep disturbances and psychosocial adaptation, especially in the early stages of therapy. However, adherence to a regular and continuous hemodialysis schedule has been reported to improve patients' quality of life over time (Aditama et al., 2023).

Monitoring kidney function through serum creatinine remains the most commonly used parameter for estimating glomerular filtration rate. Increased serum creatinine levels not only reflect a decline in kidney function but also correlate with an increased risk of mortality and cardiovascular complications (Verdiansah, 2016). Creatinine is the end product of muscle metabolism excreted by the kidneys, so its accumulation in the blood is a sensitive indicator of impaired renal filtration (Aditya et al., 2018). The National Kidney Disease Education Program specifically recommends serum creatinine testing as the basis for evaluating glomerular filtration function and monitoring the progression of kidney disease (Verdiansah, 2016).

Research has demonstrated that hemodialysis plays a significant role in lowering serum creatinine levels in patients with chronic kidney disease (CKD). Studies by Sudrajat and Fetriyana (2023) and Ningsih et al. (2021) reported a significant decrease in creatinine levels after hemodialysis, which is often used as an indicator of treatment success. At Bali Husada Cipta Canthi (BHCC) Clinic in Denpasar City, the number of hemodialysis patients has continued to increase over the past three years. However, data on serum creatinine levels before and after hemodialysis remain relatively limited. This situation requires further study to understand changes in creatinine levels during hemodialysis therapy. Therefore, research on differences in creatinine levels before and after hemodialysis in patients with chronic kidney failure at the Bali Husada Cipta Canthi Clinic is important.

2. Method

2.1 Research Design and Participants

The study used an analytical observational design with a cross-sectional approach to evaluate differences in serum creatinine levels before and after hemodialysis in a group of subjects over the same period. The study was conducted at the Bali Husada Cipta Canthi (BHCC) Clinic, Denpasar City. The population covered in this study comprised all stage V chronic renal failure patients who underwent serum creatinine testing before and after hemodialysis. The number of patients who met these criteria was 18. The research sample was determined by total sampling (Subhaktiyasa, 2024).

2.2 Instruments and Data Collection

Data were obtained retrospectively by reviewing medical records and patient registers at the BHCC Clinic Hemodialysis Unit. The information collected included basic patient identity, kidney disease stage, and serum creatinine test results before and after hemodialysis. The determination of CKD stage was based on clinical data recorded in medical records at the time the patient underwent health services. Serum creatinine testing followed laboratory procedures through pre-analytical, analytical, and post-analytical stages. The pre-analytical stage included patient preparation and blood specimen collection. The analytical stage was performed according to the serum creatinine test procedure used in the clinical laboratory, while the post-analytical stage included recording and validating the test results. The entire data collection process was carried out by health workers and laboratory analysts at the BHCC Clinic, in accordance with applicable standard operating procedures.

2.3 Data Analysis

The data were analyzed using descriptive statistics to describe the characteristics of the respondents and inferential statistics to answer the research objectives (Subhaktiyasa et al., 2025). A normality test was performed, followed by an analysis of the difference in serum creatinine levels before and after hemodialysis using a paired sample t-test. However, prior to this, the test was conducted to assess the difference in means between the two measurement conditions. Before the analysis, the data were checked for completeness and organized systematically. Data processing and analysis were performed using SPSS.

2.4 Ethical Considerations

The study utilizes clinical data sourced from patient medical records. Patient confidentiality is maintained by excluding names and other personal information that could identify research subjects. Data is used solely for research purposes.

3. Results and Discussion

3.1 Results

18 patients with chronic kidney failure undergoing hemodialysis at the Bali Husada Cipta Canthi (BHCC) Clinic in Denpasar City participated in this study. Patient characteristics are presented in Table 1.

Table 1. Characteristics of chronic kidney failure patients undergoing hemodialysis

Caracteristic	n	f (%)
Age (year)		
15 – 24	1	5.6
25 – 34	2	11.1
35 – 44	3	16.7
45 – 54	5	27.8
55 – 64	7	38.9
> 64	0	0
Gender		
Female	6	33.3
Male	12	66.7
Type of Comorbidity		
Hypertension (HT)	7	38.9
Diabetes Mellitus (DM)	6	33.3
Cancer	1	5.6
HT and DM	3	16.7
None	1	5.6
Smoking Status		
Yes	8	44.4
No	10	55.6

Table 1 shows that the majority of respondents were male (66.7%), while female patients accounted for only 33.3%. The most common comorbidities were hypertension (38.9%) and diabetes mellitus (33.3%), while 16.7% of patients had a combination of both conditions. Nearly half of the respondents were recorded as active smokers (44.4%).

Table 2. Serum creatinine levels in chronic renal failure patients before and after hemodialysis

	Mean (mg/dl)	N	SD	Min – Max (mg/dl)
Pre-Hemodialysis	12.36	18	4.35	4.03 – 20.60
Post-Hemodialysis	4.91	18	2.51	1.70 – 10.10

Table 2 explains the difference in mean serum creatinine levels before and after hemodialysis. The mean serum creatinine level before hemodialysis was 12.36 mg/dl, and after hemodialysis, it decreased to 4.91 mg/dl. A narrowing of the serum creatinine range also accompanied this decrease. Before hemodialysis, creatinine levels ranged from 4.03 to 20.60 mg/dl; after hemodialysis, the range was 1.70 to 10.10 mg/dl.

A normality test was then performed, and a p-value > 0.05 was obtained; therefore, a Paired Sample t-test was performed, with results shown in Table 3.

Table 3. Results of the Paired Sample t-test for serum creatinine levels before and after hemodialysis

	Mean (mg/dl)	t	df	Sig.	95% CI
Pre–Hemodialysis Post–Hemodialysis	7.45	13.81	17	< 0.001	6.31 – 8.59

Table 3 shows a difference in mean serum creatinine levels of 7.45 mg/dl between before and after hemodialysis. The t-value obtained was 13.81 with a degree of freedom (df) of 17 and a significance value of < 0.001. The 95% confidence interval was 6.31-8.59 mg/dl. These findings indicate a significant difference in serum creatinine levels between pre- and post-hemodialysis measurements.

3.2 Discussion

This study aims to analyze the difference in serum creatinine levels before and after hemodialysis in patients with chronic kidney failure. The findings indicate that hemodialysis plays a significant role in lowering serum creatinine levels. It confirms the effectiveness of this therapy as a substitute for renal excretory function in patients with advanced CKD (Ningsih et al., 2021; Sari et al., 2021).

The results show that the majority of CKD patients are in the 55–64 age group, indicating that the risk of CKD increases with age. This pattern is consistent with the 2018 Riskesdas data, which reports an increase in the prevalence of CKD in the elderly (Indonesian Ministry of Health, 2019). The aging process causes a gradual decline in glomerular filtration rate due to decreased nephron number and function, thereby limiting the kidneys' ability to excrete metabolic products (Tampake & Doho, 2021). This decline in renal functional reserve often goes unnoticed until it reaches an advanced stage.

Most patients in this study were male, in line with Riskesdas reports and previous findings showing a predominance of CKD cases in men (Baroleh et al., 2019). Purwati (2018) even mentioned that men have up to five times higher risk of developing end-stage CKD compared to women. This difference is influenced not only by biological factors but also by health behaviors, in which women tend to be more compliant with treatment and more consistent in maintaining a healthy lifestyle (Purwati, 2018). In addition, men are more often exposed to systemic risk factors such as hypertension and diabetes mellitus, and have higher rates of smoking and alcohol consumption, which accelerate the decline in kidney function (Tampake & Doho, 2021).

Almost all CKD patients in this study had comorbidities, particularly hypertension and diabetes mellitus. These findings are consistent with the studies by Doni Wahdi and Srikandi Syahadat (2022) and Purwati (2018), which identified these two conditions as the dominant comorbidities in CKD patients. Hypertension increases intraglomerular pressure, causing progressive structural damage to the kidneys, while diabetes mellitus triggers diabetic nephropathy through mechanisms of glucotoxicity and microvascular dysfunction (Indonesian Ministry of Health, 2023; Purwati, 2018). The combination of these two diseases accelerates the onset of glomerulosclerosis and reduces renal blood flow, thereby worsening the progression of CKD. In addition, nearly half of the patients in this study were active smokers, consistent with Purwati's (2018) study. Smoking is known to increase the risk of CKD by up to five times through hemodynamic and non-hemodynamic mechanisms, including increased sympathetic nervous system activity and endothelial dysfunction (Setyawan, 2021). Exposure to nicotine and toxic substances in cigarettes causes an increase in renal vascular resistance, which leads to a decrease in glomerular filtration rate (Purwati, 2018). Aisyah et al. (2015) also confirmed that the intensity and duration of smoking are closely related to the degree of kidney damage, making this habit an important risk factor that needs to be considered in the management of CKD.

The main findings show a significant decrease in serum creatinine levels after hemodialysis, confirming the therapy's effectiveness in removing metabolic waste from the blood. These results are consistent with those of Purnawinadi (2021) and Sudrajat and Fetriyana (2023), who reported a significant decrease in creatinine levels following hemodialysis. This decrease occurs through diffusion and ultrafiltration processes in the semi-permeable membrane of the dialysis machine, which functions similarly to standard kidney filtration (Purnawinadi, 2021). However, serum creatinine levels after hemodialysis in CKD patients in this study were still above normal values. This finding aligns with Erwinsyah's (2014) research. This condition is due to creatinine's relatively large molecular size, which prevents its complete elimination during a single hemodialysis session. In addition, creatinine is constantly produced by skeletal muscles, so its levels are influenced by the patient's muscle mass and body weight (Alfonso et al., 2016). This finding confirms that hemodialysis is substitutive, not curative, so monitoring creatinine levels is still necessary as an indicator of long-term therapy success. The results reinforce the importance of serum creatinine testing as a key parameter for evaluating the effectiveness of hemodialysis in patients with CKD. These findings also emphasize the importance of regular monitoring of patients' kidney function.

4. Conclusion

This study shows that hemodialysis reduces serum creatinine levels in patients with chronic kidney failure undergoing treatment at the Bali Husada Cipta Canthi Clinic. The significant decrease in mean creatinine levels after therapy confirms the role of hemodialysis as an effective substitute intervention in assisting the elimination of metabolic waste in patients with advanced CKD. These findings strengthen the use of serum creatinine as a relevant laboratory indicator for monitoring hemodialysis effectiveness in clinical practice. However, interpretation of these research results should consider the limitations of the sample size and cross-sectional design. Further studies using a longitudinal design with a larger sample are needed, as well as the exploration of other renal function parameters to obtain a more comprehensive picture of the physiological response of CKD patients to hemodialysis therapy.

Conflict of Interest

The authors declare no conflict of interest.

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