THE RELATIONSHIP BETWEEN CHRONIC KIDNEY DISEASE AND ISCHEMIC EVENTS IN HEMODIALYSIS PATIENTS AT RAA SOEWONDO PATI REGIONAL HOSPITAL

Faiz Agung Hermawan[1*], Rebecca[2], Muhammad Algifari Mufadhal Alwan[3], Mustika Mahbubi[4]
Medical Professional Program, Faculty of Medicine, Tarumanagara *University,* Jakarta, Indonesia[1,2,3],
Department of Cardiology, RAA Soewondo Pati *Regional Hospital, Central Java,* Indonesia[4]
**Corresponding Author :* faizagungh@gmail.com

ABSTRAK

Diperkirakan 800 juta orang di seluruh dunia diantisipasi akan terkena penyakit ginjal kronis (PGK) pada tahun 2017, menjadikannya beban kesehatan global yang signifikan. Lanskap mortalitas telah menunjukkan tren yang memprihatinkan, dengan CKD meningkat secara signifikan dalam peringkat global penyebab utama kematian dari posisi ke-19 pada tahun 2013 menjadi ke-13 pada tahun 2016 dan ke-12 pada tahun 2017 naik menjadi penyebab kematian paling umum kelima pada tahun 2040. Kejadian iskemik, atau iskemia miokardium diam, yang ditandai dengan perubahan elektrokardiografi (EKG) asimtomatik, termasuk inversi gelombang T dan depresi segmen ST, merupakan komplikasi kardiovaskular yang meluas dan kurang dikenali yang memengaruhi pasien hemodialisis. Tujuan penelitian ini adalah untuk mengetahui hubungan antara CKD dengan kejadian iskemia pada pasien hemodialisis. Penelitian ini merupakan penelitian observasional potong lintang antara September dan November 2024, yang dilakukan di Rumah Sakit Daerah RAA Soewondo Pati. Prosedur EKG dilakukan selama hemodialisis. Kami melakukan analisis statistik menggunakan uji *chi-square*. Sampel dalam penelitian ini berjumlah 50 orang. Usia pasien berkisar antara 43 hingga 65 tahun dan sebagian besar berjenis kelamin laki-laki (58%). Komorbiditas yang paling umum adalah DM (38%), dan kejadian iskemik terjadi pada 56% pasien. Lamanya PGK dan kejadian iskemia berkorelasi secara statistik signifikan (95% CI: 1,262–4,220; PRR: 2,308; p = 0,005). Pasien dengan PGK ≥ 6 bulan memiliki faktor risiko 2,3 kali lebih tinggi untuk mengalami kejadian iskemik dibandingkan dengan pasien dengan PGK < 6 bulan.

Kata kunci : diabetes melitus, hemodialisis, iskemia miokard, kejadian iskemik, penyakit ginjal kronis

ABSTRACT

An estimated 800 million individuals worldwide were anticipated to be affected by chronic kidney disease (CKD) in 2017, making it a significant global health burden. The mortality landscape has shown concerning trends, with CKD rising dramatically in the global ranking of leading causes of death—from the 19th position in 2013 to the 13th in 2016 and the 12th in 2017 moving up to the fifth most common cause of death by 2040. Ischemic events, or silent myocardial ischemia, characterized by asymptomatic electrocardiographic (ECG) changes, including T-wave inversion and ST-segment depression, represent a pervasive and underrecognized cardiovascular complication affecting hemodialysis patients. The purpose of this study is to reveal the association between CKD and ischemia events in hemodialysis patients. This study is an observational cross-sectional study between September and November of 2024, it was carried out at RAA Soewondo Pati Regional Hospital. ECG procedures were performed during hemodialysis. We conducted statistical analysis utilizing the chi-square test. The sample in this study was 50 people. Patients ranged in age from 43 to 65 years and were predominantly male (58%). The most common comorbidity was DM (38%), and ischemic events occurred in 56% of patients. The length of CKD and ischemia events were statistically significantly correlated (95% CI: 1.262–4.220; PRR: 2.308; p = 0.005). Patients with CKD ≥ 6 months have a 2.3-fold higher risk factor for experiencing ischemic events compared to patients with CKD < 6 months.

Keywords *: chronic kidney disease, ischemic events, myocardial ischemia, diabetes mellitus, hemodialysis*

INTRODUCTION

An estimated 800 million individuals worldwide were anticipated to be affected by chronic kidney disease (CKD) in 2017, making it a significant global health burden (Kovesdy, 2022). The prevalence varies significantly by geographic region and socioeconomic status, Lower- and middle-income nations have higher percentages of men (10.6%) and women (12.5%) compared to high-income nations, which have 8.6% for men and 9.6% for women. The mortality landscape has shown concerning trends, with CKD rising dramatically in the global ranking of leading causes of death from the 19th position in 2013 to the 13th in 2016, 12th in 2017 and moving up to the fifth most common cause of death by 2040 (Kovesdy, 2022). Ischemic events or silent myocardial ischemia, characterized by asymptomatic electrocardiographic (ECG) changes including T-wave inversion and ST-segment depression, represents a pervasive and underrecognized cardiovascular complication affecting hemodialysis patients worldwide.

The global prevalence of ischemic events in hemodialysis populations ranges from 16% to 60% (Chirakarnjanakorn et al., 2017), with recent studies demonstrating that 44.7% of chronic hemodialysis patients exhibit dynamic ST-segment changes during 48-hour continuous monitoring (Narula et al., 1996). These ECG abnormalities manifest as ST-segment depression with maximum depths reaching 4mm, often occurring without accompanying symptoms of angina or hemodynamic instability (Narula et al., 1996). According to recent data, almost 80% of hemodialysis patients have at least one type of cardiovascular disease when they first start dialysis, with ECG abnormalities serving as early markers of underlying cardiac pathology (Echefu et al., 2023). The significance of these findings is magnified by the observation that sudden cardiac death accounts for 25% of all mortality in end-stage renal disease (ESRD) patients (Waks et al., 2016), with an incidence of 50 events per 1.000 person-years with a rate 10-20-fold higher than the general population (Echefu et al., 2023; Chirakarnjanakorn et al., 2017).

The hemodialysis procedure itself induces characteristic ECG changes that reflect the complex interplay. These include fluid shifts, electrolyte fluctuations, and cardiovascular stress responses (Chirakarnjanakorn et al., 2017). Recent studies demonstrate that all hemodialysis patients exhibit some degree of ECG changes, with the most pronounced alterations occurring during the first two hours of dialysis, including decreased T-wave amplitude (100% of patients), and ischemic-like ST-T changes, such as 22% of patients having ST-segment depression and 44% having T-wave inversion (Shapira et al., 1992). Rapid changes in blood volume and electrolytes, especially potassium and calcium, contribute to hemodynamic stress and ECG changes (Chirakarnjanakorn et al., 2017).

The epidemiological landscape reveals substantial regional variations in the prevalence and clinical significance of ECG ischemic changes among hemodialysis patients. Studies demonstrate that ECG abnormalities are present in 65% of maintenance hemodialysis patients, with rates significantly higher in elderly, hypertensive, and diabetic populations (Abe et al., 1996). North American data from the National Inpatient Sample reveals that ST-segment depression serves as an independent predictor of 30-day mortality in hospitalized patients, with adjusted odds ratios of 1.24 for mortality risk (Greig et al., 2014). Other data demonstrates improving survival trends among dialysis patients with acute myocardial infarction, with in-hospital mortality decreasing from 31.9% in 1993 to 18.8% in 2008, though patients with ECG changes continue to experience significantly elevated mortality rates (Shroff et al., 2015).

In Indonesia, the most comprehensive national study by Andhika et al. analyzing 122.449 patients showed a one-year survival rate of 91.5% (95% CI: 91.3-91.6) among ESRD patients undergoing hemodialysis, with ECG abnormalities serving as significant predictors of mortality (Andhika et al., 2025). Dewayani's comprehensive review documented that

cardiovascular mortality rates in dialysis patients were 20 times higher than the normal population, with cardiovascular disease causing 44% of all deaths in dialysis patients (Dewayani, 2007). According to Ramatillah et al., cardiovascular illness significantly increased mortality among Indonesian hemodialyzed patients, and the length of the disease affected the chance of dying (HR 2.39, p=0.006) (Ramatillah et al., 2020). Ischemic events in CKD patients emphasize the importance of ECG monitoring as part of comprehensive management. The purpose of this study is to reveal the association between CKD and ischemia events in hemodialysis patients at RAA Soewondo Pati Regional Hospital.

METHODS

This study is an observational cross-sectional study conducted between September and November 2024. The study was carried out at RAA Soewondo Pati Regional Hospital. Inclusion criteria included all CKD patients undergoing hemodialysis during the study period. Exclusion criteria included a history of previous heart infarction, chronic heart failure, congenital heart disease, heart valve abnormalities, and patients undergoing treatment (amiodarone, verapamil, propanolol, or phenobarbital). Data were obtained using consecutive sampling techniques. ECG procedures were performed during hemodialysis. Ischemic events were identified in patients with T-wave inversion or ST-segment depression during hemodialysis as seen from ECG results. Statistical analysis was performed using SPSS version 25, with the chi-square test applied to examine associations. The study sample consisted of 50 patients.

RESULTS

Table 1. Characteristics of Study Subjects

Characteristics	Amount (N = 50)	Mean (± SD)	Median (Min-Max)
Sex			
Male	29 (58%)	-	-
Female	21 (42%)	-	-
Age	-	51.1 (± 6, 02)	50 (43-65)
Duration of CKD			
≥ 6 months	26 (52%)	-	-
< 6 months	24 (48%)	-	-
Comorbid			
Hypertension	15 (30%)	-	-
DM Type 2*	19 (38%)	-	-
HT and DM Type 2*	8 (16%)	-	-
Didn't have HT or DM Type 2*	8 (16%)	-	-
Ischemic Events			
Yes	28 (56%)	-	-
No	22 (44%)	-	-

A total of 50 patients met the inclusion criteria. Patients ranged in age from 43 to 65 years and were predominantly male, with 58% of them. Approximately 52% of patients had CKD for ≥ 6 months. The most common comorbidity was DM, at 38%. Ischemic events occurred in 56% of patients in this study (see table 1).

Table 2. The Relationship Between Duration of CKD and Ischemic Events

Duration of CKD	Ischemic Events		p-value	PRR (95% CI)
	Yes (%)	No (%)		
≥ 6 months	20 (40%)	6 (12%)	0.005	2.308 (1,262 – 4,220)
< 6 months	8 (16%)	16 (32%)		

The length of CKD and ischemia events were statistically significantly correlated (p = 0.005). Additionally, compared to individuals with CKD duration < 6 months, those with CKD length ≥ 6 months had a 2.3-fold increased risk of ischemia events (see table 2).

DISCUSSION

The present study's demographic profile reveals significant insights into the cardiovascular risk landscape among hemodialysis patients. The male predominance (58%) observed in our cohort aligns consistently with established epidemiological patterns in CKD populations worldwide. Previous studies have consistently demonstrated this male preponderance, with Sy et al. reporting a sex ratio of 1.26 (55.7% male) in chronic hemodialysis patients (Sy et al., 2020), while Mohamud et al. found 53% male predominance in their Somali hemodialysis cohort (Mohamud et al., 2023). Hidayat et al. also reported that people with CKD in 11 provinces and at Immanuel Hospital were dominated by men, with 51.8% and 53.1%, respectively (Hidayat et al., 2023). This gender disparity reflects the well-established understanding that male sex constitutes an independent traditional cardiovascular risk factor in CKD, as documented by Vallianou et al., who identified male gender among the mutual risk factors between cardiovascular disease and CKD (Vallianou et al., 2019). The age range of 43-65 years in our study population represents a particularly vulnerable demographic, as cardiovascular disease prevalence increases substantially with advancing age in CKD patients, with nearly half of CKD patients being older than 70 years according to contemporary epidemiological data (Arora, 2025).

The identification of DM as the most common comorbidity (38%) in our study reflects a global trend in end-stage renal disease epidemiology, where diabetic nephropathy has become the leading cause of kidney failure. This prevalence aligns with contemporary data showing that almost half of US dialysis patients developed ESRD as a result of type 2 DM. The cardiovascular implications of this finding are particularly concerning, as Drechsler et al. demonstrated in the German Diabetes and Dialysis Study (4D Study) involving 1.255 hemodialysis patients with type 2 diabetes that poor glycemic control significantly increases cardiovascular mortality risk. In particular, individuals with HbA1c >8% were more than twice as likely to die from sudden cardiac death as those with HbA1c ≤ 6% (HR 2.14; 95% CI 1.33-3.44), and the risk of dying suddenly increased by 18% for every 1% increase in HbA1c (Drechsler et al., 2009). The coexistence of diabetes and CKD creates a particularly ominous cardiovascular risk profile, as Chen et al. documented that patients with both DM and ESRD have substantially elevated risks, with adjusted hazard ratios of 2.77 for all-cause mortality and 1.87 for cardiovascular mortality compared to non-CKD patients (Chen et al., 2024).

The finding that 52% of patients had CKD duration ≥ 6 months, with this factor showing statistical significance (p = 0.005) for ischemic events, highlights the correlation between the development of CKD and the increase of cardiovascular risk over time. Cabrera et al. demonstrated in their landmark UK Clinical Practice Research Data Link study of 30.222 CKD patients that disease progression rates significantly impact cardiovascular outcomes, with eGFR slope decline >-3 ml/min/1.73 m² increasing major adverse cardiovascular events risk by 45% (HR = 1.45; 95% CI, 1.26-1.67). This temporal association reflects the cumulative burden of uremic toxins, chronic inflammation, and progressive cardiovascular remodeling that occurs as CKD advances (Cabrera et al., 2020). Echefu et al. documented that the time to cardiovascular events is shorter for dialysis patients with de novo ischemic heart disease (24 months compared to 55 months for non-dialysis patients). This accelerated cardiovascular disease progression reflects the cumulative impact of chronic uremia on cardiovascular structure and function. Susantitaphong et al. demonstrated through meta-analysis that significant variations in serum electrolytes and extracellular fluid volume are linked to

traditional hemodialysis, contributing to left ventricular hypertrophy development and cardiovascular remodeling over time (Susantitaphong et al., 2012).

The 2.3-fold increased risk observed in patients with CKD duration ≥ 6 months aligns with evidence from Jankowski et al., who documented that in patients with advanced CKD, cardiovascular mortality makes up 40–50% of all deaths, while in controls with normal kidney function, it makes up 26% (Jankowski et al., 2021). The mechanisms underlying this elevated ischemic risk are multifactorial, encompassing both traditional cardiovascular risk factors (HT, DM or dyslipidemia) and CKD-specific pathophysiology (Marx-Schutt et al., 2025; Jankowski et al., 2021). Several studies comprehensively documented that fluid overload, mineral and bone abnormalities, inflammation, uremic cardiomyopathy, oxidative stress, secondary hyperparathyroidism, anemia, and the buildup of uremic toxins produced from the gut microbiota, such as trimethylamine N-oxide (TMAO), are among the cardiovascular changes brought on by renal dysfunction. Additionally, the hemodialysis procedure itself poses myocardial stress through rapid volume and electrolyte shifts, with the highest risk of cardiovascular events occurring within the first 12 hours after dialysis and following long interdialytic intervals (Ahmadmehrabi et al., 2018; Marx-Schutt et al., 2025).

The identification of CKD duration as an independent risk factor for ischemic events has profound implications for clinical risk stratification and management strategies in hemodialysis populations. Contemporary evidence-based guidelines emphasize the importance of aggressive cardiovascular risk modification in CKD patients, with the 2024 KDIGO and ESC guidelines recommending stringent blood pressure control, statin therapy, and renin-angiotensin system inhibition (Levin et al., 2023). Perone et al. recently emphasized that the risk of cardiovascular disease is high and very high for people with CKD, and it rises as the estimated glomerular filtration rate falls (Perone et al., 2025). The 2.3-fold increased risk associated with CKD duration ≥ 6 months in our study suggests that intensive cardiovascular monitoring and intervention protocols should be implemented early in the hemodialysis course. Zannad et al. demonstrated that treatment strategies to reduce cardiovascular risk in CKD patients require multidisciplinary approaches, with data showing that cardiovascular disease risk is almost three times as prevalent in CKD stage 4-5 compared to earlier stages (Zannad et al., 2024). This temporal risk stratification should inform clinical decision-making regarding frequency of cardiovascular assessments, imaging studies, and preventive interventions.

CONCLUSION

This study concluded that there is a relationship between CKD and ischemic events in hemodialysis patients, where patients with CKD ≥ 6 months have a 2.3-fold higher risk factor for experiencing ischemic events compared to patients with CKD < 6 months.

ACKNOWLEDGMENT

We are appreciative of the assistance provided by Tarumanagara University and RAA Soewondo Pati Regional Hospital in the completion of this study.

REFERENCES

Abe, S., Yoshizawa, M., Nakanishi, N., Yazawa, T., Yokota, K., Honda, M., & Sloman, G. (1996*). Electrocardiographic abnormalities in patients receiving hemodialysis*. *American Heart Journal, 131*(6), 1137-1144. https://doi.org/10.1016/S0002-8703(96)90088-5

Ahmadmehrabi, S., & Tang, W. H. W. (2018). *Hemodialysis-induced cardiovascular disease*. *Seminars in dialysis, 31*(3), 258–267. https://doi.org/10.1111/sdi.12694

Andhika, R., Afiatin, Supriyadi, R., Bandiara, R., Sukesi, L., Sudarmadi, A. P., Wahyudi, K., & Sofiatin, Y. (2025). *One-year Survival of End-Stage Kidney Disease Patients Undergoing Hemodialysis in Indonesia*. *International journal of nephrology and renovascular disease, 18*, 87–101. https://doi.org/10.2147/IJNRD.S508012

Arora, P. (2025). *Chronic Kidney Disease (CKD). Medscape* [serial online]. https://emedicine.medscape.com/article/238798-overview

Cabrera, C. S., Lee, A. S., Olsson, M., Schnecke, V., Westman, K., Lind, M., Greasley, P. J., & Skrtic, S. (2020). *Impact of CKD Progression on Cardiovascular Disease Risk in a Contemporary UK Cohort of Individuals with Diabetes. Kidney international reports, 5*(10), 1651–1660. https://doi.org/10.1016/j.ekir.2020.07.029

Chen, Y.T., Lin, C.C., Huang, P.H., Li, S.Y. (2024). *Comparative analysis of hemodialysis and peritoneal dialysis on the risk of new onset diabetes mellitus*. *Journal of the Formosan Medical Association, 123*(5), 606-612. https://doi.org/10.1016/j.jfma.2024.01.013

Chirakarnjanakorn, S., Navaneethan, S. D., Francis, G. S., & Tang, W. H. (2017). *Cardiovascular impact in patients undergoing maintenance hemodialysis: Clinical management considerations*. *International journal of cardiology, 232*, 12–23. https://doi.org/10.1016/j.ijcard.2017.01.015

Dewayani, R. (2007). Penyakit jantung koroner pada *chronic kidney disease*. Jurnal Kardiologi Indonesia, 28(5), 387-395.

Drechsler, C., Krane, V., Ritz, E., Marz, W., Wanner, C. (2009). *Glycemic Control and Cardiovascular Events in Diabetic Hemodialysis Patients. AHA Circulation, 120*(4), 2421-2428. https://doi.org/10.1161/CIRCULATIONAHA.109.857268

Echefu, G., Stowe, I., Burka, S., Basu-Ray, I., & Kumbala, D. (2023). *Pathophysiological concepts and screening of cardiovascular disease in dialysis patients. Frontiers in nephrology, 3*, 1198560. https://doi.org/10.3389/fneph.2023.1198560

Greig, D., Austin, P.C., Zhou, L., Tu, J.V., Pang, P.S., Ross, H.J., Lee, D.S. (2014). *Ischemic Electrocardiographic Abnormalities and Prognosis in Decompensated Heart Failure. AHA Circulation: Heart Failure, 7*(6), 986-993. https://doi.org/10.1161/CIRCHEARTFAILURE.114.001460

Hidayat, M., Motulo, F., Chandra, S., Andamari, S., Sulungbudi, J., Lesmana, R. (2023). *Analysis of influencing factors in chronic kidney disease incidence in Indonesia*. *Indonesian Journal of Medicine and Health, 14*(3), 296-305. https://doi.org/10.20885/JKKI.Vol14.Iss3.art10

Jankowski, J., Floege, J., Fliser, D., Bohm, M., Marx, N. (2021). *Cardiovascular Disease in Chronic Kidney Disease: Pathophysiological Insights and Therapeutic Options*. *AHA Circulation, 143*(11), 1157-1172. https://doi.org/10.1161/CIRCULATIONAHA.120.050686

Kovesdy, C. P. (2022). *Epidemiology of chronic kidney disease: an update 2022*. *Kidney international supplements, 12*(1), 7–11. https://doi.org/10.1016/j.kisu.2021.11.003

Levin, A., Ahmed, S.B., Carrero, J.J., Foster, B., Francis, A., Hall, R.K., … & Stevens, P.E. (2023). *Executive summary of the KDIGO 2024 Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease: known knowns and known unknowns. Kidney International, 105*, 684-701. https://kdigo.org/wp-content/uploads/2017/02/KDIGO-2024-CKD-Guideline-Executive-Summary.pdf

Marx-Schutt, K., Cherney, D.Z.I., Jankowski, J., Matsushita, K., Nardone, M., Marx, N. (2025). *Cardiovascular disease in chronic kidney disease*. *European Heart Journal, 46*(23), 2148-2160. https://doi.org/10.1093/eurheartj/ehaf167

Mohamud, M.F.Y., Adan, F.N., Jeele, M.O.O., M., & Ahmed, M.A.M. (2023). *Major cardiovascular events and associated factors among routine hemodialysis patients with*

end-stage renal disease at tertiary care hospital in Somalia. Frontiers in medicine, 10, 1086359. https://doi.org/10.3389/fmed.2023.1086359

Narula, A. S., Bali, H. S., Sakhuja, V., Chugh, K. S., & Oberoi, H. S. (1996). *Silent Myocardial Ischemia In Hemodialysis Patients - Factor Fiction?. Medical journal, Armed Forces India, 52*(2), 110–112. https://doi.org/10.1016/S0377-1237(17)30855-9

Perone, F., Bernardi, M., Loguercio, M., Jacoangeli, F., Velardi, S., Metsovitis, T., Ramondinoe, F., Ruzzolini, M., Ambrosetti, M. (2025). *Cardiovascular disease risk assessment, exercise training, and management of complications in patients with chronic kidney disease. International Journal of Cardiology Cardiovascular Risk and Prevention, 25*, 200386. https://doi.org/10.1016/j.ijcrp.2025.200386

Ramatillah, D. L., Sulaiman, S. A. S., & Khan, K. U. (2020). *Potential risk factors for mortality due to cardiovascular disease among hemodialysed patients in Indonesia*. *Pharmaceutical Sciences and Research, 7*(2), 99-104. https://scholarhub.ui.ac.id/cgi/viewcontent.cgi?article=1096&context=psr

Shapira, O.M., & Bar-Khayim, Y. (1992). *ECG Changes and Cardiac Arrhythmias in Chronic Renal Failure Patients on Hemodialysis*. *Journal of Electrocardiology, 25*(4), 273-279. https://doi.org/10.1016/0022-0736(92)90032-U

Shroff, G. R., Li, S., & Herzog, C. A. (2015). *Trends in Mortality Following Acute Myocardial Infarction Among Dialysis Patients in the United States Over 15 Years*. *Journal of the American Heart Association, 4*(10), e002460. https://doi.org/10.1161/JAHA.115.002460

Susantitaphong, P., Koulouridis, I., Balk, E. M., Madias, N. E., & Jaber, B. L. (2012). *Effect of frequent or extended hemodialysis on cardiovascular parameters: a meta-analysis. American journal of kidney diseases: the official journal of the National Kidney Foundation, 59*(5), 689–699. https://doi.org/10.1053/j.ajkd.2011.12.020

Sy, S., Samaké, M., Coulibaly, M., Konaté, M., Diallo, D., Yat- tara, H., Fofana, A.S., Kodio, A., Sidibé, M., Coulibaly, N., Touré, A., Sy, D., Tangara, M. and Fongoro, S. (2020) *Prevalence of Cardi- ovascular Risk Factors in Chronic Hemo- dialysis Patients at the University Hospital Center of Point G in Bamako, Mali. Open Journal of Nephrology, 10*, 125-134. https://doi.org/10.4236/ojneph.2020.102013

Vallianou, N. G., Mitesh, S., Gkogkou, A., & Geladari, E. (2019). *Chronic Kidney Disease and Cardiovascular Disease: Is there Any Relationship?*. *Current cardiology reviews, 15*(1), 55–63. https://doi.org/10.2174/1573403X14666180711124825

Waks, J. W., Tereshchenko, L. G., & Parekh, R. S. (2016*). Electrocardiographic predictors of mortality and sudden cardiac death in patients with end stage renal disease on hemodialysis. Journal of electrocardiology, 49*(6), 848–854. https://doi.org/10.1016/j.jelectrocard.2016.07.020

Zannad, F., McGuire, D. K., & Ortiz, A. (2024). *Treatment strategies to reduce cardiovascular risk in persons with chronic kidney disease and Type 2 diabetes*. *Journal of internal medicine, 297*(5), 460–478. https://doi.org/10.1111/joim.20050