Higher Inpatient mortality following Percutaneous Coronary Intervention in Patients with Advanced Chronic Kidney Disease.

Mohammad Reza Movahed[1]

[1]Affiliation not available

December 14, 2023

INTRODUCTION:

Advanced chronic kidney disease is described as stages 3-5 of the chronic kidney disease classification defined as a reduction in glomerular filtration rate of less than 60 ml/min (1). Chronic kidney disease (CKD) has been known as one of the prominent risk factors for coronary artery disease (2). Percutaneous coronary intervention (PCI) has become an acceptable alternative to open heart surgery in patients suffering from coronary artery disease (3). This procedure improves patient survival, appropriately controls angina symptoms, reduces the need for long-term hospitalization, and reduces treatment costs (4-5). However, similar to other invasive or even minimally invasive therapeutic interventions, this procedure should be performed in high-risk groups with some considerations and precautions. These patients may experience far different outcomes than low-risk patients who have PCI. In patients with chronic kidney disorders, the need to use contrast material, scheduling consecutive dialysis sessions, the risk of microembolization, and requiring arterial wall instrumentation may lead to poorer outcomes of the PCI procedure, and the clinical benefits of PCI may be lower in such patients (6). In the last decade, various trials have evaluated the outcomes of the procedure in patients with CKD, which were basically associated with contradictory results. In a large, randomized trial (ISCHEMIA-CKD) on 777 CKD patients who underwent PCI procedure or medical therapy, 3.2-year outcomes including death, cardiac ischemic attack, or re-hospitalization were shown to be similar in both groups (7). In several trials, the presence of underlying chronic kidney disease was considered a major risk factor for long-term poorer outcomes following PCI, such as higher mortality and progression of renal impairment (8-9), also the impaired renal elimination of antithrombotic drugs exposes these patients to a higher likelihood of bleeding complications (10-11). During our literature review on databases, we found a small number of studies looking into the impacts of PCI on ACKD patients, Limpijankit and his colleague as one of the few studies in this matter determined one-year survival of PCI among 207 CKD patients stage 4-5 without dialysis and 5 with dialysis was 65.2%, 68.0% and 69.4 respectively (12). Therefore, the outcome of PCI procedures in patients with ACKD still remains uncertain. In the present study, we investigated the clinical outcomes of PCI in cases with Advanced chronic kidney disease and compared the in-patient mortality rate of PCI between ACKD and non-ACKD candidates.

MATERIALS AND METHODS

The data source of this retrospective study was the National Inpatient Sample (NIS) data registry that consisted of a complete set of background, intra-operative, and postoperative information of the patients undergoing PCI procedures. The collected information included demographic characteristics, underlying cardiac risk factors, laboratory findings at the time of admission, characteristics related to coronary artery involvement, such as the severity of involvement and the number of coronary arteries under the procedure, and intra- and postoperative outcomes during hospitalization. Patients were classified into two groups with ACKD and without this co-morbidity. The in-patient death defined as death that occurred postoperatively during hospitalization was the parameter of interest.

The Kolmogorov-Smirnov test was primarily used to assess the normality states of the study variables. The Chi-square test was applied to determine the statistical differences between categorical parameters, while the t-test or Mann-Whitney U test was employed to assess the difference between quantitative variables. To determine the values of chronic renal failure to predict in-hospital death following PCI, the multivariate logistic regression analysis was used with the presence of baseline variables. P values of [?] 0.05 were considered significant. The statistical software SPSS version 28.0 for Windows (IBM, Armonk, New York) was used for statistical analyses.

RESULTS

In this study, among 1826536 patients who were candidates for PCI from 2005 to 2011, 113018 patients (6.2%) suffered from ACKD, based on the criteria for diagnosis of chronic kidney disease. Patients with kidney disease mostly were older and had histories of diabetics, peripheral artery disease, cerebrovascular accidents, and atrial fibrillation as compared to the patients without renal insufficiency (Table 1). The evaluation of the trend of the changes in procedural mortality during the evaluated years (from 2005 to 2011) in two groups of patients with and without advanced chronic kidney disease indicated higher age-adjusted inpatient mortality rate in the group with ACKD in each year studied compared to those without this co-morbidity. However, over the years mortality in ACKD patients undergoing PCI improved over the years study while it was stable with a mild increase in non-CKD patients. (Figure 1) For the first year studied in 2006, age age-adjusted mortality rate for patients undergoing PCI was 149 per 100,000 vs 48 per 100,000 in patients without ACKD ($p<0001$). For the last year studied in 2011, age-adjusted mortality was 124.1 per 100,000 in ACKD patients vs 40.4 per 100,000 in patients with no ACKD, ($P <0.0001$).

Using the multivariable logistic regression modeling adjusting for baseline parameters and cardiovascular risk factors such as diabetes mellitus, hypertension, hyperlipidemia, peripheral artery disease, atrial fibrillation, cerebrovascular disease, myocardial infarction, and tobacco use, ACKD remained independently associated with higher mortality (OR 1.32, CI 1.27-1.36, $P<0.001$) ($OR = 1.32$, $P < 0.001$) following PCI. Furthermore, an increasing trend of PCI performed in ACKD patients was noted over the years studied (Figure 2).

DISCUSSION

As the main results of our study, the history of ACKD remains independently associated with in-hospital death following PCI even after adjusting baseline parameters such as other cardiovascular risk profiles. In many studies, chronic renal failure, especially frequent dialysis, has been declared as a potential risk factor for adverse outcomes of therapeutic interventions in patients with coronary heart disease, especially following revascularization (13-17). This higher mortality can be explained by the use of contrast material, disorders related to circulating blood volume, thromboembolic disorders related to kidney disease, and significant hemodynamic disorders in the mentioned patients (18-20). However, a study that enrolled 344 patients who underwent elective PCI demonstrated that there was no connection between CKD and periprocedural myocardial injury after elective PCI (21). Therefore, it is still unclear whether patients with ACKD will benefit from such procedures or not. What we found in the present study was that, firstly, the presence of ACKD is a potential risk factor for increasing the risk of hospital mortality in patients undergoing PCI. Thus, along with other background risk factors, the role of ACKD can be considered prominent in mortality risk. Considering that this result was obtained by examining a large volume of PCI candidate patients, we can emphasize the solidity and reliability of the mentioned finding. Therefore, if the patient who is a candidate for this procedure was suffering from ACKD at the time of admission, to reduce morbidity and mortality after the procedure, potential measures such as control and monitoring of kidney function should be considered, especially in intensive care units. Various strategies have been considered to reduce the risk of mortality and complications after PCI in patients with ACKD. In this regard, volume expansion within the procedure, limiting contrast use, and the use of low- to iso-osmolar contrast agents can significantly reduce the risk for postoperative death (22-23).

Most of the previous studies also emphasize chronic renal failure as a potential risk factor for worse outcomes after PCI. As similarly shown by Yager et al in 2022 (24), advanced kidney disease was linked with noticeably increased post-nonemergent PCI mortality. Narcisse et al in 2020 (25) also showed that patients with chronic kidney disease remain at greater risk for major adverse vascular events and all-cause mortality after vascular interventions.

Additionally, it should be kept in mind that due to the extent of coronary artery involvement in many patients with ACKD, invasive procedures such as coronary artery bypass surgery or PCI are absolutely unavoidable in many of these patients. Choosing the most proper and safest approach for these patients is complex. Although, several studies have demonstrated that the PCI procedure is safer compared to medical treatments and PCI has not been reported to be associated with an increased risk of death. As indicated by Yong et al in 2021 (26), in patients with advanced kidney disease and coronary artery disease, PCI reduced the risk of short-, medium- and long-term all-cause death in contrast to medical treatment. However, in their study, coronary artery bypass grafting was associated with a higher risk of short-term death and a lower risk of long-term death and adverse events compared to PCI.

In our study, the increasing trend of performing PCI procedures in patients with ACKD was demonstrated. Patel et al in 2017 (27) have shown that increasing utilization of PCI among ACS patients with ACKD has led to a lower in-patient mortality in this population. The reason for this increase can be due to the advanced techniques of performing PCI, the use of safer contracting materials as well as ultra-low contrast angiography and zero-contrast PCI, more precise control of the mentioned patients during and after the operation, as well as the general modification of the protocols and guidelines for the care of these patients and more experienced operator performing PCI which may lead to lower risk of morbidity and mortality of PCI in CKD patients (28-30).

CONCLUSION

ACKD is independently associated with higher mortality in patients undergoing PCI. Therefore, PCI in these patients should be performed with more caution.

LIMITATIONS: We used ICD-9 coding with inherent limitations as administrative coding has limitations in inaccuracy. We studied patients who underwent PCI which introduces selection bias as many patients with ACKD may have been treated conservatively limiting our patients to a specifically selected group undergoing PCI based on the patient's presentation and preference.

REFERENCES

1.Go AS, Chertow GM, Fan D, McCulloch CE, Hsu CY. Chronic kidney disease and the risks of death, cardiovascular events, and hospitalization. N Engl J Med. 2004 Sep 23;351(13):1296-305. doi: 10.1056/NEJMoa041031. Erratum in: N Engl J Med. 2008;18(4):4. PMID: 15385656.

2. Webster AC, Nagler EV, Morton RL, Masson P. Chronic Kidney Disease. Lancet. 2017 Mar 25;389(10075):1238-1252

3. Al-Lamee RK, Nowbar AN, Francis DP. Percutaneous coronary intervention for stable coronary artery disease. Heart. 2019 Jan;105(1):11-19. doi: 10.1136/heartjnl-2017-312755.

4. Parikh PB, Bhatt DL, Bhasin V, Anker SD, Skopicki HA, Claessen BE, Fonarow GC, Hernandez AF, Mehran R, Petrie MC, Butler J. Impact of Percutaneous Coronary Intervention on Outcomes in Patients With Heart Failure: JACC State-of-the-Art Review. J Am Coll Cardiol. 2021 May 18;77(19):2432-2447.

5. Akbari T, Al-Lamee R. Percutaneous Coronary Intervention in Multi-Vessel Disease. Cardiovasc Revasc Med. 2022 Nov;44:80-91.

6. Wu W, Gao M, Wu X. A Systematic Review and Meta-Analysis of Influences of Chronic Kidney Disease on Patients after Percutaneous Coronary Intervention for Chronic Total Occlusions. Comput Math Methods Med. 2023 Feb 22;2023:9450752.

7. Bangalore S, Maron DJ, Fleg JL, O'Brien SM, Herzog CA, Stone GW, Mark DB, Spertus JA, Alexander KP, Sidhu MS, Chertow GM, Boden WE, Hochman JS; ISCHEMIA-CKD Research Group. International Study of Comparative Health Effectiveness with Medical and Invasive Approaches-Chronic Kidney Disease (ISCHEMIA-CKD): Rationale and design. Am Heart J. 2018 Nov;205:42-52. doi: 10.1016/j.ahj.2018.07.023. Epub 2018 Aug 1. PMID: 30172098; PMCID: PMC6283671.

8. Holzmann MJ, Siddiqui AJ. Outcome of Percutaneous Coronary Intervention During Non-ST-Segment-Elevation Myocardial Infarction in Elderly Patients With Chronic Kidney Disease. J Am Heart Assoc. 2020 Jun 16;9(12):e015084.

9. Wańha W, Kawecki D, Roleder T, Pluta A, Marcinkiewicz K, Morawiec B, Dola J, Gładysz S, Pawłowski T, Smolka G, Ochała A, Nowalany-Kozielska E, Wojakowski W. Long-Term Percutaneous Coronary Intervention Outcomes of Patients with Chronic Kidney Disease in the Era of Second-Generation Drug-Eluting Stents. Cardiorenal Med. 2017 Feb;7(2):85-95.

10. Claessen BEPM, Kikkert WJ, Hoebers LP, Bahadurzada H, Vis MM, Baan J, Koch KT, de Winter RJ, Tijssen JGP, Piek JJ, Henriques JPS. Long-term ischaemic and bleeding outcomes after primary percutaneous coronary intervention for ST-elevation myocardial infarction in the elderly. Neth Heart J. 2015 Sep;23(10):477-482.

11.Harenberg J, Hentschel VA, Du S, Zolfaghari S, Krämer R, Weiss C, Krämer BK, Wehling M. Anticoagulation in patients with impaired renal function and with haemodialysis. Anticoagulant effects, efficacy, safety, therapeutic options. Hamostaseologie. 2015;35(1):77-83. doi: 10.5482/HAMO-14-08-0036. Epub 2014 Nov 18. PMID: 25405246.

12. Limpijankit T, Chandavimol M, Srimahachota S, Kanoksilp A, Jianmongkol P, Siriyotha S, Thakkinstian A, Buddhari W, Sansanayudh N. Dose-dependent effect of impaired renal function on all-cause mortality in patients following percutaneous coronary intervention. Clin Cardiol. 2022 Aug;45(8):882-891. doi: 10.1002/clc.23877. Epub 2022 Jun 27. PMID: 35758306; PMCID: PMC9346964.

13. Reinecke H, Trey T, Matzkies F, Fobker M, Breithardt G, Schaefer RM. Grade of chronic renal failure, and acute and long-term outcome after percutaneous coronary interventions. Kidney Int. 2003 Feb;63(2):696-701.

14. Barthelemy O, Helft G, Silvain J, Bellemain-Appaix A, Beygui F, Choussat R, Berman E, Collet JP, Montalescot G, Metzger JP, Le Feuvre C. One-year clinical outcomes in patients with chronic renal failure treated by percutaneous coronary intervention with drug-eluting stent. Arch Cardiovasc Dis. 2011 Dec;104(12):604-10.

15. Limpijankit T, Chandavimol M, Srimahachota S, Kanoksilp A, Jianmongkol P, Siriyotha S, Thakkinstian A, Buddhari W, Sansanayudh N. Dose-dependent effect of impaired renal function on all-cause mortality in patients following percutaneous coronary intervention. Clin Cardiol. 2022 Aug;45(8):882-891.

16. Lee JM, Kang J, Lee E, Hwang D, Rhee TM, Park J, Kim HL, Lee SE, Han JK, Yang HM, Park KW, Na SH, Kang HJ, Koo BK, Kim HS. Chronic Kidney Disease in the Second-Generation Drug-Eluting Stent Era: Pooled Analysis of the Korean Multicenter Drug-Eluting Stent Registry. JACC Cardiovasc Interv. 2016 Oct 24;9(20):2097-2109.

17. Tasoudis PT, Varvoglis DN, Tzoumas A, Doulamis IP, Tzani A, Sá MP, Kampaktsis PN, Gallo M. Percutaneous coronary intervention versus coronary artery bypass graft surgery in dialysis-dependent patients: A pooled meta-analysis of reconstructed time-to-event data. J Card Surg. 2022 Oct;37(10):3365-3373.

18. Pilmore H, Webster M, Sidhu K, Srikumar G. Management of coronary artery disease in patients on dialysis. N Z Med J. 2017 Dec 15;130(1467):11-22.

19. Choi HY, Park HC, Ha SK. How do We Manage Coronary Artery Disease in Patients with CKD and ESRD? Electrolyte Blood Press. 2014 Dec;12(2):41-54.

20. Wang Z, Gong Y, Fan F, Yang F, Qiu L, Hong T, Huo Y. Coronary artery bypass grafting vs. drug-eluting stent implantation in patients with end-stage renal disease requiring dialysis. Ren Fail. 2020 Nov;42(1):107-112.

21. Jerkic H, Letilovic T, Stipinovic M, Pocanic D, Catic J, Knotek M. Association of chronic kidney disease with periprocedural myocardial injury after elective stent implantation: A single center prospective cohort study. Medicine (Baltimore). 2016 Nov;95(45):e5381. doi: 10.1097/MD.0000000000005381. PMID: 27828870; PMCID: PMC5106076..

22. Weisbord SD, Palevsky PM. Prevention of contrast-induced nephropathy with volume expansion. Clin J Am Soc Nephrol. 2008;3(1):273–280.

23. McCullough PA, Choi JP, Feghali GA, Schussler JM, Stoler RM, Vallabahn RC, Mehta A. Contrast-induced acute kidney injury. J Am Coll Cardiol. 2016;68(13):1465–1473.

24. Yager N, Hongalgi K, Torosoff M. Chronic Kidney Disease and Post-Percutaneous Coronary Intervention Mortality in Patients With Left Main and Equivalent Coronary Artery Disease. Tex Heart Inst J. 2022 Sep 1;49(5):e217670.

25. Dennis I Narcisse 1, Elizabeth Hope Weissler 2 3 4, Jennifer A Rymer 1 2, Ehrin J Armstrong 5, Eric A Secemsky 6, William A Gray 7, Jihad A Mustapha 8, George L Adams 9, Gary M Ansel 10, Manesh R Patel 1 2, William Schuyler Jones 1 2. The impact of chronic kidney disease on outcomes following peripheral vascular intervention. Clin Cardiol. 2020 Nov;43(11):1308-1316. doi: 10.1002/clc.23444. Epub 2020 Aug 11.

26. Jingwen Yong 1, Jinfan Tian 1, Xin Zhao 1, Xueyao Yang 1, Haoran Xing 1, Yi He 2, Xiantao Song 3. Optimal treatment strategies for coronary artery disease in patients with advanced kidney disease: a meta-analysis. Ther Adv Chronic Dis. 2021 Jul 7;12:20406223211024367. doi: 10.1177/20406223211024367. eCollection 2021.

27. Brijesh Patel 1, Mahek Shah 1, Raman Dusaj 1, Sharon Maynard 1, Nainesh Patel 1. Percutaneous coronary intervention and inpatient mortality in patients with advanced chronic kidney disease presenting with acute coronary syndrome. Proc (Bayl Univ Med Cent). 2017 Oct;30(4):400-403. doi: 10.1080/08998280.2017.11930205.

28. Ali ZA, Escaned J, Dudek D, Radhakrishnan J, Karimi Galougahi K. Strategies for Renal Protection in Cardiovascular Interventions. Korean Circ J. 2022 Jul;52(7):485-495. doi: 10.4070/kcj.2022.0093. PMID: 35790493; PMCID: PMC9257153.

29. Kumar, Prathap & Jino, Blessvin & Shafeeq, Ali & Roy, Stalin & Rajendran, Manu & Villoth, Sandheep George. (2021). IVUS-Guided Zero-Contrast PCI in CKD Patients: Safety and Short-Term Outcome in Patients with Complex Demographics and/or Lesion Characteristics. Journal of Interventional Cardiology. 2021. 1-7. 10.1155/2021/6626749.

30. Caracciolo A, Scalise RFM, Ceresa F, Bagnato G, Versace AG, Licordari R, Perfetti S, Lofrumento F, Irrera N, Santoro D, Patanè F, Di Bella G, Costa F, Micari A. Optimizing the Outcomes of Percutaneous Coronary Intervention in Patients with Chronic Kidney Disease. J Clin Med. 2022 Apr 23;11(9):2380. doi: 10.3390/jcm11092380. PMID: 35566504; PMCID: PMC9100167.

Table 1: Baseline characteristics of study population

Characteristics	ACKD group (n = 113018)	Non-ACKD group (n = 1713518)	P value
Mean age, year	67.78±11.74	64.85±12.03	<0.001
Male gender, %	57.91%	60.65%	< 0.001
Race, %			<0.001
White	49.42%	61.84%	

Characteristics	ACKD group (n = 113018)	Non-ACKD group (n = 1713518)	P value
Black	18.80%	8.07%	
Hispanic	9.27%	5.64%	
Asian/Pac Isl	2.60%	1.60%	
Native Americn	0.64%	0.56%	
Other	19.28%	22.30	
History of diabetes mellitus	52.9%	31.8%	<0.001
History of tobacco use	15.4%	31.8%	<0.001
History of hypertension	1.1%	61.8%	<0.001
History of hyperlipidemia	44.9%	60.0%	<0.001
History of myocardial infarction	10.2%	12.1%	<0.001
History of peripheral artery disease	11.7%	6.7%	<0.001
History of atrial fibrillation	18.6%	14.2%	<0.001
History of cerebrovascular disease	3.0%	2.5%	<0.001

[CHART]

Figure 1: The trend of the changes in age-adjusted mortality rate within study period

[CHART][CHART]

Figure 2: The trend of the changes in age-adjusted PCI rate within study period