Outcomes of Percutaneous Coronary Intervention in Acute Myocardial Infarction Patients with Chronic Kidney Disease: Insights from the National Inpatient Sample

Analysis for RCOP NIS Cardio12

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## Preamble:

* **Reference Papers:**
  + [Holzmann et al. (2020)](https://doi.org/10.1161/JAHA.119.015084)
* **Study Objective**: Examine the impact of percutaneous coronary intervention (PCI) among inpatient admissions with a principal admission of acute myocardial infarction (MI) and a history of chronic kidney disease (CKD).
* **Data Source**: Cross-sectional analysis of the National Inpatient Sample (NIS) from 2018 to 2020.
* **Patient Selection**: Included all inpatient admissions with a principal diagnosis of MI and a history of CKD.
* **MI + CKD + PCI Categories**:
  + MI + CKD with PCI
  + MI + CKD without PCI
* **Primary Outcomes**:
  + In-hospital all-cause mortality
  + Total hospital length of stay (days)
  + Total charge, inflation adjusted to 2020 ($) [adjusted to 2020 dollars, using CPI data by the U.S. Bureau of Labor Statistics]
* **Statistical Analysis**: Multiple logistic and linear regression to determine the independent association of PCI on outcomes, adjusted for:
  + Demographics: Age, sex, race, insurance, residential income, and residential region.
  + Medical History: MI type, CKD class, prior MI, and prior PCI.
  + Comorbidities: Charlson comorbidity index, atrial fibrillation, cerebrovascular disease, heart failure, diabetes mellitus, hyperlipidemia, hypertension, and peripheral vascular disease.
* **Software:** All analyses were performed using R Version 4.4.1 (R Foundation for Statistical Computing, Vienna, Austria)

## Baseline Table:

| **Characteristic** | **Overall**, N = 370,355 | **No PCI**, N = 238,230 | **PCI**, N = 132,125 | **p-value** |
| --- | --- | --- | --- | --- |
| Age, y | 72 (12) | 73 (12) | 71 (12) | <0.001 |
| Sex |  |  |  | <0.001 |
| Female | 144,245 (39) | 96,310 (40) | 47,935 (36) |  |
| Male | 226,100 (61) | 141,915 (60) | 84,185 (64) |  |
| Race |  |  |  | <0.001 |
| White | 243,110 (67) | 153,130 (66) | 89,980 (70) |  |
| Asian or Pacific Islander | 13,630 (3.8) | 8,980 (3.9) | 4,650 (3.6) |  |
| Black | 57,540 (16) | 39,465 (17) | 18,075 (14) |  |
| Hispanic | 35,620 (9.8) | 23,770 (10) | 11,850 (9.2) |  |
| Native American | 2,575 (0.7) | 1,550 (0.7) | 1,025 (0.8) |  |
| Other | 9,375 (2.6) | 5,845 (2.5) | 3,530 (2.7) |  |
| MI type |  |  |  | <0.001 |
| Non-ST-elevation MI | 295,415 (80) | 199,050 (84) | 96,365 (73) |  |
| Other MI | 25,685 (6.9) | 23,975 (10) | 1,710 (1.3) |  |
| ST-elevation MI | 49,255 (13) | 15,205 (6.4) | 34,050 (26) |  |
| CKD stage |  |  |  | <0.001 |
| CKD, Stage 1 | 2,350 (0.6) | 1,315 (0.6) | 1,035 (0.8) |  |
| CKD, Stage 2 | 24,960 (6.7) | 14,420 (6.1) | 10,540 (8.0) |  |
| CKD, Stage 3 | 204,195 (55) | 128,175 (54) | 76,020 (58) |  |
| CKD, Stage 4 | 51,995 (14) | 38,025 (16) | 13,970 (11) |  |
| CKD, Stage 5 | 6,310 (1.7) | 4,780 (2.0) | 1,530 (1.2) |  |
| ESKD | 80,545 (22) | 51,515 (22) | 29,030 (22) |  |
| Charlson comorbidity index | 5.77 (1.56) | 5.86 (1.56) | 5.60 (1.53) | <0.001 |
| Expected primary payer |  |  |  | <0.001 |
| Private | 51,290 (14) | 30,075 (13) | 21,215 (16) |  |
| Medicaid | 24,220 (6.5) | 16,005 (6.7) | 8,215 (6.2) |  |
| Medicare | 286,270 (77) | 186,820 (78) | 99,450 (75) |  |
| Other | 8,235 (2.2) | 5,120 (2.2) | 3,115 (2.4) |  |
| Residential income |  |  |  | <0.001 |
| $1 - $51,999 | 116,335 (32) | 76,345 (33) | 39,990 (31) |  |
| $52,000 - $65,999 | 101,180 (28) | 65,020 (28) | 36,160 (28) |  |
| $66,000 - $87,999 | 84,550 (23) | 53,280 (23) | 31,270 (24) |  |
| $88,000 or more | 62,630 (17) | 39,890 (17) | 22,740 (17) |  |
| Residential region |  |  |  | 0.21 |
| Large metro | 184,075 (50) | 118,915 (50) | 65,160 (49) |  |
| Micropolitan | 72,225 (20) | 46,520 (20) | 25,705 (19) |  |
| Small metro | 113,030 (31) | 72,040 (30) | 40,990 (31) |  |
| Atrial fibrillation | 94,270 (25) | 65,985 (28) | 28,285 (21) | <0.001 |
| Cerebrovascular disease | 35,430 (9.6) | 24,575 (10) | 10,855 (8.2) | <0.001 |
| Heart failure | 247,410 (67) | 166,625 (70) | 80,785 (61) | <0.001 |
| Diabetes mellitus | 233,395 (63) | 149,000 (63) | 84,395 (64) | <0.001 |
| Hyperlipidemia | 267,640 (72) | 166,840 (70) | 100,800 (76) | <0.001 |
| Hypertension | 354,700 (96) | 228,345 (96) | 126,355 (96) | 0.17 |
| Peripheral vascular disease | 64,435 (17) | 43,840 (18) | 20,595 (16) | <0.001 |
| Prior MI | 79,360 (21) | 50,955 (21) | 28,405 (21) | 0.74 |
| Prior PCI | 75,000 (20) | 47,530 (20) | 27,470 (21) | 0.008 |

## Outcomes Table:

| **Characteristic** | **Overall**, N = 370,355 | **No PCI**, N = 238,230 | **PCI**, N = 132,125 | **p-value** |
| --- | --- | --- | --- | --- |
| Died during hospitalization | 24,765 (6.7) | 17,630 (7.4) | 7,135 (5.4) | <0.001 |
| Length of stay (days) | 4.0 (2.0 – 7.0) | 4.0 (2.0 – 8.0) | 4.0 (2.0 – 7.0) | <0.001 |
| Inflation-adjusted total charge ($) | 71,586 (36,593 – 136,805) | 49,014 (26,741 – 104,518) | 106,876 (72,323 – 170,451) | <0.001 |

## Multivariable Logistic Regression:

### All-Cause Mortality:

| **Characteristic** | **OR** **(95% CI)** | **p-value** |
| --- | --- | --- |
| PCI status |  |  |
| No PCI | — |  |
| PCI | 0.60 (0.55 to 0.64) | <0.001 |
| Age, y | 1.03 (1.03 to 1.03) | <0.001 |
| Sex |  |  |
| Female | — |  |
| Male | 0.98 (0.92 to 1.04) | 0.44 |
| Race |  |  |
| White | — |  |
| Asian or Pacific Islander | 1.13 (0.96 to 1.32) | 0.13 |
| Black | 0.86 (0.78 to 0.95) | 0.002 |
| Hispanic | 0.95 (0.85 to 1.06) | 0.35 |
| Native American | 1.31 (0.93 to 1.86) | 0.12 |
| Other | 0.99 (0.82 to 1.19) | 0.90 |
| MI type |  |  |
| Non-ST-elevation MI | — |  |
| Other MI | 0.79 (0.69 to 0.90) | <0.001 |
| ST-elevation MI | 3.76 (3.47 to 4.06) | <0.001 |
| CKD stage |  |  |
| CKD, Stage 1 | — |  |
| CKD, Stage 2 | 1.23 (0.72 to 2.11) | 0.45 |
| CKD, Stage 3 | 1.61 (0.95 to 2.72) | 0.075 |
| CKD, Stage 4 | 2.12 (1.25 to 3.60) | 0.005 |
| CKD, Stage 5 | 2.89 (1.66 to 5.03) | <0.001 |
| ESKD | 3.43 (2.03 to 5.79) | <0.001 |
| Charlson comorbidity index | 1.07 (1.04 to 1.10) | <0.001 |
| Expected primary payer |  |  |
| Private | — |  |
| Medicaid | 0.83 (0.70 to 0.99) | 0.036 |
| Medicare | 0.96 (0.86 to 1.06) | 0.42 |
| Other | 1.00 (0.79 to 1.25) | 0.98 |
| Residential income |  |  |
| $1 - $51,999 | — |  |
| $52,000 - $65,999 | 1.03 (0.95 to 1.12) | 0.49 |
| $66,000 - $87,999 | 1.00 (0.92 to 1.10) | 0.94 |
| $88,000 or more | 1.08 (0.98 to 1.19) | 0.11 |
| Residential region |  |  |
| Large metro | — |  |
| Micropolitan | 1.01 (0.92 to 1.11) | 0.83 |
| Small metro | 1.06 (0.98 to 1.14) | 0.12 |
| Atrial fibrillation |  |  |
| No | — |  |
| Yes | 1.22 (1.14 to 1.30) | <0.001 |
| Cerebrovascular disease |  |  |
| No | — |  |
| Yes | 1.24 (1.12 to 1.37) | <0.001 |
| Heart failure |  |  |
| No | — |  |
| Yes | 1.75 (1.61 to 1.90) | <0.001 |
| Diabetes mellitus |  |  |
| No | — |  |
| Yes | 0.86 (0.80 to 0.94) | <0.001 |
| Hyperlipidemia |  |  |
| No | — |  |
| Yes | 0.61 (0.57 to 0.65) | <0.001 |
| Hypertension |  |  |
| No | — |  |
| Yes | 0.74 (0.65 to 0.85) | <0.001 |
| Peripheral vascular disease |  |  |
| No | — |  |
| Yes | 1.07 (0.98 to 1.16) | 0.13 |
| Prior MI |  |  |
| No | — |  |
| Yes | 0.80 (0.73 to 0.86) | <0.001 |
| Prior PCI |  |  |
| No | — |  |
| Yes | 0.72 (0.66 to 0.79) | <0.001 |

## Multivariable Linear Regression:

### Length of Stay:

| **Characteristic** | **Beta** **(95% CI)** | **p-value** |
| --- | --- | --- |
| PCI status |  |  |
| No PCI | — |  |
| PCI | -0.38 (-0.49 to -0.27) | <0.001 |
| Age, y | -0.02 (-0.03 to -0.02) | <0.001 |
| Sex |  |  |
| Female | — |  |
| Male | 0.12 (0.02 to 0.22) | 0.015 |
| Race |  |  |
| White | — |  |
| Asian or Pacific Islander | 0.11 (-0.20 to 0.43) | 0.48 |
| Black | -0.16 (-0.33 to 0.00) | 0.054 |
| Hispanic | 0.21 (-0.01 to 0.42) | 0.060 |
| Native American | 0.26 (-0.41 to 0.93) | 0.45 |
| Other | 0.51 (0.11 to 0.90) | 0.012 |
| MI type |  |  |
| Non-ST-elevation MI | — |  |
| Other MI | -1.1 (-1.3 to -0.96) | <0.001 |
| ST-elevation MI | 0.32 (0.15 to 0.49) | <0.001 |
| CKD stage |  |  |
| CKD, Stage 1 | — |  |
| CKD, Stage 2 | -0.07 (-0.56 to 0.41) | 0.77 |
| CKD, Stage 3 | 0.05 (-0.42 to 0.52) | 0.84 |
| CKD, Stage 4 | 0.53 (0.04 to 1.0) | 0.033 |
| CKD, Stage 5 | 0.36 (-0.21 to 0.93) | 0.22 |
| ESKD | 0.98 (0.48 to 1.5) | <0.001 |
| Charlson comorbidity index | 0.21 (0.16 to 0.25) | <0.001 |
| Expected primary payer |  |  |
| Private | — |  |
| Medicaid | 0.15 (-0.15 to 0.45) | 0.33 |
| Medicare | -0.33 (-0.51 to -0.16) | <0.001 |
| Other | -0.03 (-0.37 to 0.32) | 0.88 |
| Residential income |  |  |
| $1 - $51,999 | — |  |
| $52,000 - $65,999 | -0.14 (-0.28 to -0.01) | 0.032 |
| $66,000 - $87,999 | -0.09 (-0.24 to 0.05) | 0.21 |
| $88,000 or more | -0.20 (-0.38 to -0.02) | 0.026 |
| Residential region |  |  |
| Large metro | — |  |
| Micropolitan | -0.59 (-0.74 to -0.44) | <0.001 |
| Small metro | -0.35 (-0.49 to -0.21) | <0.001 |
| Atrial fibrillation |  |  |
| No | — |  |
| Yes | 1.2 (1.1 to 1.3) | <0.001 |
| Cerebrovascular disease |  |  |
| No | — |  |
| Yes | 1.9 (1.7 to 2.1) | <0.001 |
| Heart failure |  |  |
| No | — |  |
| Yes | 2.0 (1.8 to 2.1) | <0.001 |
| Diabetes mellitus |  |  |
| No | — |  |
| Yes | 0.02 (-0.11 to 0.16) | 0.74 |
| Hyperlipidemia |  |  |
| No | — |  |
| Yes | -0.90 (-1.0 to -0.77) | <0.001 |
| Hypertension |  |  |
| No | — |  |
| Yes | -0.31 (-0.64 to 0.02) | 0.064 |
| Peripheral vascular disease |  |  |
| No | — |  |
| Yes | -0.32 (-0.45 to -0.19) | <0.001 |
| Prior MI |  |  |
| No | — |  |
| Yes | -1.0 (-1.1 to -0.94) | <0.001 |
| Prior PCI |  |  |
| No | — |  |
| Yes | -1.1 (-1.2 to -1.0) | <0.001 |

### Inflation Adjusted Total Charge:

| **Characteristic** | **Beta** **(95% CI)** | **p-value** |
| --- | --- | --- |
| PCI status |  |  |
| No PCI | — |  |
| PCI | 44,193 (41,016 to 47,371) | <0.001 |
| Age, y | -1,011 (-1,133 to -889) | <0.001 |
| Sex |  |  |
| Female | — |  |
| Male | 10,397 (7,955 to 12,839) | <0.001 |
| Race |  |  |
| White | — |  |
| Asian or Pacific Islander | 28,076 (17,763 to 38,389) | <0.001 |
| Black | -14,427 (-18,581 to -10,273) | <0.001 |
| Hispanic | 28,670 (22,738 to 34,602) | <0.001 |
| Native American | 6,021 (-9,821 to 21,864) | 0.46 |
| Other | 32,633 (18,646 to 46,620) | <0.001 |
| MI type |  |  |
| Non-ST-elevation MI | — |  |
| Other MI | -38,587 (-42,183 to -34,991) | <0.001 |
| ST-elevation MI | 24,801 (20,027 to 29,575) | <0.001 |
| CKD stage |  |  |
| CKD, Stage 1 | — |  |
| CKD, Stage 2 | -8,449 (-24,431 to 7,532) | 0.30 |
| CKD, Stage 3 | -11,802 (-27,564 to 3,960) | 0.14 |
| CKD, Stage 4 | -13,606 (-29,639 to 2,426) | 0.10 |
| CKD, Stage 5 | -15,398 (-33,151 to 2,354) | 0.089 |
| ESKD | 16,519 (-124 to 33,163) | 0.052 |
| Charlson comorbidity index | -142 (-1,272 to 989) | 0.81 |
| Expected primary payer |  |  |
| Private | — |  |
| Medicaid | -8,030 (-14,907 to -1,154) | 0.022 |
| Medicare | -6,622 (-11,763 to -1,481) | 0.012 |
| Other | 2,444 (-6,602 to 11,491) | 0.60 |
| Residential income |  |  |
| $1 - $51,999 | — |  |
| $52,000 - $65,999 | -2,613 (-5,974 to 747) | 0.13 |
| $66,000 - $87,999 | -784 (-4,820 to 3,252) | 0.70 |
| $88,000 or more | 613 (-4,807 to 6,034) | 0.82 |
| Residential region |  |  |
| Large metro | — |  |
| Micropolitan | -31,807 (-36,133 to -27,480) | <0.001 |
| Small metro | -15,712 (-20,620 to -10,804) | <0.001 |
| Atrial fibrillation |  |  |
| No | — |  |
| Yes | 25,841 (22,718 to 28,965) | <0.001 |
| Cerebrovascular disease |  |  |
| No | — |  |
| Yes | 38,333 (33,494 to 43,172) | <0.001 |
| Heart failure |  |  |
| No | — |  |
| Yes | 34,707 (31,807 to 37,607) | <0.001 |
| Diabetes mellitus |  |  |
| No | — |  |
| Yes | 6,779 (3,313 to 10,245) | <0.001 |
| Hyperlipidemia |  |  |
| No | — |  |
| Yes | -15,983 (-19,334 to -12,632) | <0.001 |
| Hypertension |  |  |
| No | — |  |
| Yes | -7,238 (-15,430 to 955) | 0.083 |
| Peripheral vascular disease |  |  |
| No | — |  |
| Yes | -2,109 (-5,849 to 1,630) | 0.27 |
| Prior MI |  |  |
| No | — |  |
| Yes | -20,827 (-23,365 to -18,289) | <0.001 |
| Prior PCI |  |  |
| No | — |  |
| Yes | -23,297 (-25,830 to -20,765) | <0.001 |