Percutaneous coronary intervention and inpatient mortality in patients with advanced chronic kidney disease presenting with acute coronary syndrome.

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Percutaneous coronary intervention and inpatient mortality in patients with advanced chronic kidney disease presenting with acute coronary syndrome

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Chronic kidney disease (CKD) is an important risk factor for coronary artery disease, yet patients with CKD are less likely to undergo coronary angiography and percutaneous coronary intervention (PCI). We retrospectively analyzed the 2006–2012 National Inpatient Sample Database to examine the temporal trends in coronary angiography and PCI among patients without CKD, with advanced CKD (CKD III–V), and with end-stage renal disease (ESRD) presenting with unstable angina/non–ST elevation myocardial infarction (NSTE-ACS) and ST-elevation myocardial infarction (STEMI). A total of 579,747 admissions for NSTE-ACS and 293,950 admissions for STEMI were studied. Patients with NSTE-ACS were less likely to undergo coronary angiography/PCI than those with STEMI, irrespective of CKD. Between 2006 and 2012, performance of PCI saw an uptrend across all CKD groups with NSTE-ACS (no CKD, 29.9%–36.8%; CKD III–V, 18.2%–21.5%; ESRD, 19.8%–27.5%; all $P_{trends} < 0.01$) and STEMI (no CKD, 57.0%–76.0%; CKD III–V, 33.0%–52.6%; ESRD, 29.9%–42.9%; $P_{trends} < 0.01$). Multivariate analyses revealed that PCI was associated with a lower risk of hospital mortality across all degrees of CKD in both NSTE-ACS (adjusted odds ratios: no CKD, 0.44; CKD III–V, 0.48; ESRD, 0.46; $P < 0.01$) and STEMI (no CKD, 0.35; CKD III–V, 0.50; ESRD, 0.52; $P < 0.01$). Performance of PCI increased over time among patients presenting with NSTE-ACS and STEMI in the presence of advanced CKD and independently predicted lower in-hospital mortality.

Chronic kidney disease (CKD) is associated with an increased risk for development of complex coronary artery disease. At the same time, coronary angiography (CAG) carries a high risk of contrast-induced nephropathy (CIN) in this population. Patients with CKD experience higher rates of bleeding, drug-related adverse events, strokes, and need for dialysis, as well as longer hospital stays and increased mortality following coronary revascularization when compared to patients with normal kidney function (1). The objective of our study was to examine temporal trends in performance of CAG and percutaneous coronary intervention (PCI) among patients presenting with acute coronary syndrome (ACS) according to their baseline renal function.

METHODS

We queried the unweighted 2006–2012 National Inpatient Sample (2) to identify patients aged ≥18 years with a primary diagnosis of acute myocardial infarction (AMI) (ICD-9CM codes 410x and 411.1). Patients were separated into three categories depending on baseline renal function: no CKD, CKD stage III–V, and end-stage renal disease (ESRD) on chronic dialysis (ICD-9CM codes: 585.3-6, 585.9). A chi-square test was used to compare categorical variables. Trend analysis was performed using the Mantel-Haenszel linear test of trend. We created separate multivariable logistic regression models based on the degree of CKD (no CKD, CKD III–V, ESRD) within the group of patients presenting with non–ST elevation myocardial infarction (NSTE)–ACS and ST-elevation myocardial infarction (STEMI) to evaluate the relationship between performance of PCI and in-hospital mortality. Within these models, we adjusted for several risk factors, including patient characteristics (demographics, comorbidities), hospital characteristics (bed size, location, and teaching status), admission characteristics (year, weekend), and primary insurance payer.

RESULTS

A total of 579,747 admissions for NSTE-ACS and 293,950 admissions for STEMI were studied. Patients with advanced stages of CKD had higher proportions of women and comorbidities, but lesser proportions of Caucasians, compared to patients with normal baseline renal function in both the NSTE-ACS and STEMI groups *(Tables 1 and 2)*. As shown in *Figure 1,* use of both CAG and PCI increased for NSTE-ACS and STEMI during the study duration, irrespective of CKD status. However, patients with CKD and ESRD were less likely to undergo CAG/PCI than those without CKD. By the year 2012, two-thirds of patients with CKD or ESRD underwent CAG. Interestingly, patients with CKD III–V were less likely to undergo CAG than ESRD patients when presenting with NSTE-ACS (45.7% vs. 56.4%) in 2012. For any given year, NSTE-ACS patients were less likely to undergo CAG/PCI than patients with STEMI, regardless of CKD status. Even though two-thirds of NSTE-ACS

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Table 1. NSTE-ACS group patient characteristics

Variable	No CKD (n = 513,185)	CKD stages III–V (n = 41,999)	ESRD (n = 24,563)	*P* value
Age >65 years	54.5%	80.0%	56.3%	<0.001
Caucasian	63.3%	64.5%	43.2%	<0.001
Female gender	43.4%	43.1%	44.1%	0.004
Alcohol abuse	3.0%	1.3%	1.0%	<0.001
Chronic pulmonary disease	21.7%	26.6%	21.7%	<0.001
Diabetes mellitus	33.1%	54.1%	62.5%	<0.001
Hypertension	67.5%	82.0%	87.4%	<0.001
Metastatic cancer	0.9%	0.9%	0.6%	<0.001
Obesity	12.3%	14.1%	10.0%	<0.001
Peripheral vascular disease	10.1%	21.7%	23.2%	<0.001
Bed size of hospital				
Small	11.0%	10.5%	7.9%	<0.001
Medium	24.4%	23.8%	23.0%	
Large	64.6%	65.8%	69.1%	
Teaching status of hospital				
Rural	12.0%	10.4%	7.1%	<0.001
Urban nonteaching	42.5%	42.9%	41.2%	
Urban teaching	45.4%	46.6%	51.7%	
Weekend admission	25.1%	26.3%	23.1%	<0.001
Elective admission	7.2%	5.5%	6.2%	<0.001

CKD indicates chronic kidney disease; ESRD, end-stage renal disease; NSTE-ACS, non-ST elevation acute coronary syndrome.

Table 2. STEMI group patient characteristics

Variable	No CKD (n = 281,106)	CKD stages III–V (n = 8123)	ESRD (n = 4721)	*P* value
Age >65 years	42.2%	77%	57.2%	<0.001
Caucasian	63.9%	65%	45.9%	<0.001
Female gender	33.6%	41.7%	43.9%	<0.001
Alcohol abuse	3.2%	1.2%	1.0%	<0.001
Chronic pulmonary disease	15.5%	21.6%	17.2%	<0.001
Diabetes mellitus	25.6%	47.1%	56.6%	<0.001
Hypertension	58.2%	81.1%	85.2%	<0.001
Metastatic cancer	0.7%	1%	0.5%	<0.001
Obesity	10.4%	12.7%	8.8%	<0.001
Peripheral vascular disease	7%	17.8%	21.2%	<0.001
Bed size of hospital				
Small	10.2%	11.2%	9.2%	<0.001
Medium	22.6%	22.8%	22.3%	
Large	67.2%	66%	68.4%	
Teaching status of hospital				
Rural	10.8%	11.4%	9.1%	<0.001
Urban nonteaching	42.8%	43.2%	43.8%	
Urban teaching	46.4%	45.4%	47.1%	
Weekend admission	27.5%	26.5%	25.4%	<0.001
Elective admission	7.1%	6.3%	7.1%	0.007

CKD indicates chronic kidney disease; ESRD, end-stage renal disease; STEMI, ST-elevation myocardial infarction.

patients without CKD had CAG, slightly more than half of them received PCI. Higher all-cause hospital mortality was noted among those with an advanced degree of renal dysfunction, with the mortality risk being higher in STEMI than in NSTE patients.

About one-fourth of STEMI patients with ESRD died during hospitalization. The prevalence of in-hospital mortality was nearly double in the STEMI patients than in the NSTE-ACS patients. After adjusting for key variables, performance of PCI in NSTE-ACS was associated with a lower risk of hospital mortality across all degrees of CKD, with adjusted odds ratios of 0.44 for no CKD, 0.48 for CKD III–V, and 0.46 for ESRD. Similarly, PCI in STEMI independently predicted lower in-hospital mortality across the CKD spectrum, with adjusted odds ratios of 0.35 for no CKD, 0.50 for CKD III–V, and 0.52 for ESRD *(Table 3)*.

DISCUSSION

Our study showed that an increasing number of patients undergo CAG and PCI for any renal stages, and PCI was associated with marked reduction in mortality risk. Importantly, among patients presenting with STEMI, more underwent CAG and PCI from 2006 to 2012, though there was a disparity between patients with or without CKD. CKD is a known risk factor for increased AMI-related mortality (1). Charytan and colleagues previously reported underperformance of PCI in CKD patients, but the data represented only

Table 3. Adjusted odd ratios for in-hospital mortality for patients undergoing percutaneous coronary intervention

Presentation	Baseline renal function	Odd ratio (95% CI)	*P* value
NSTE-ACS	No CKD	0.44 (0.42–0.47)	<0.001
	CKD III-V	0.48 (0.42–0.56)	<0.001
	ESRD	0.46 (0.40–0.53)	<0.001
STEMI	No CKD	0.35 (0.34–0.36)	<0.001
	CKD III-V	0.50 (0.43–0.58)	<0.001
	ESRD	0.52 (0.45–0.61)	<0.001

CI indicates confidence interval; CKD, chronic kidney disease; ESRD, end-stage renal disease; NSTE-ACS, non-ST elevation acute coronary syndrome; STEMI, ST-elevation myocardial infarction. The model is adjusted for age, gender, race, Charlson comorbidity index, weekend and elective admissions, insurance type, alcohol abuse, anemia, arthritic conditions, chronic lung disease, coagulopathy, depression, diabetes, drug abuse, hypertension, hypothyroidism, liver disease, fluids and electrolyte disorders, obesity, peripheral vascular disease, pulmonary circulatory disorders, year of admission, bed size and teaching status/location of hospitals, acute kidney injury, lymphoma, metastatic cancer, psychosis, solid tumor without metastases, and percutaneous coronary interventions.

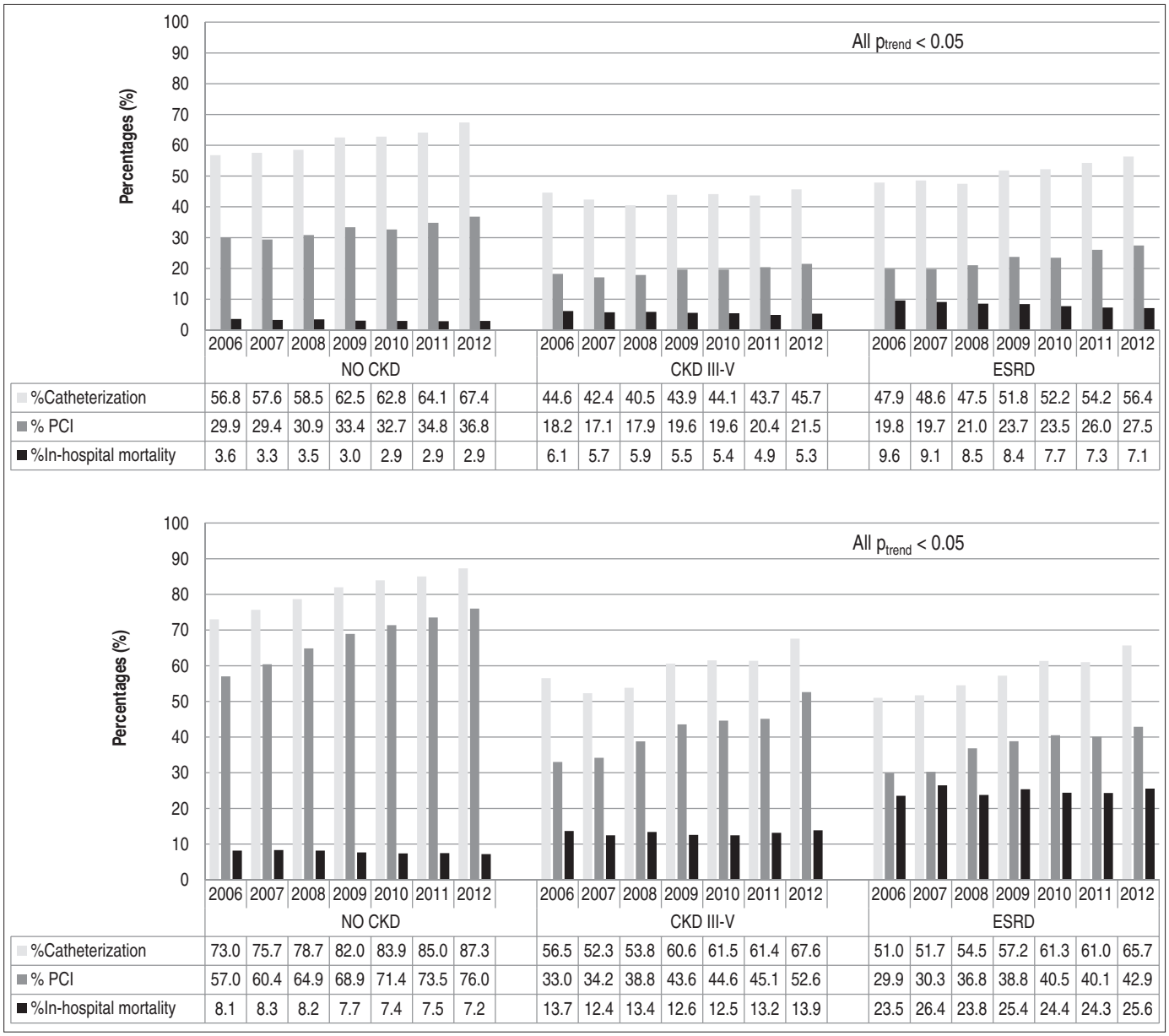

Figure 1. Cardiac catheterization, percutaneous interventions, and inpatient mortality from 2006 to 2012 in **(a)** patients presenting with unstable angina/non–ST elevation myocardial infarction according to baseline renal function and **(b)** patients presenting with ST-elevation myocardial infarction according to baseline renal function. CKD indicates chronic kidney disease; ESRD, end-stage renal disease; STEMI, ST elevation myocardial infarction.

1 year of analysis (3). PCI is associated with higher contrast exposure, increasing the risk for CIN and long-term renal impairment. Strategies such as volume expansion reduce the incidence of CIN, allowing clinicians to expand use of PCI among higher-risk populations (4). Another strategy involves a more selective approach to left ventriculography, thus limiting contrast use with renal dysfunction. Overall reductions in the absolute contrast volume and use of low- to iso-osmolar contrast agents have been associated with a lower risk of CIN (5). Patient choice plays a significant role in the decision-making process when presented with the higher risk for dialysis among those with increasing severity of CKD. Improvements in practice and evolution in physician and patient attitudes may have contributed to the overall uptrend in performance of CAG and PCI.

Our study has several limitations inherent to its retrospective design, use of an administrative database, and dependence on ICD-9CM coding. We were unable to determine the temporal relationship between acute kidney injury and PCI/CAG which would influence decision making. The overall PCI rate was relatively low, maybe due to revascularization at a separate visit. We chose to exclude patients with an undetermined stage of CKD and did not examine trends in alternative revascularization strategies. We relied on diagnosis codes to stratify the groups, and the database does not provide information on CIN.

In summary, there has been an increase in the use of PCI between 2006 and 2012 among patients with AMI, irrespective of the presence of baseline CKD. Patients with advanced CKD and AMI were less likely to undergo CAG or subsequent PCI and experienced a higher rate of in-hospital mortality compared

to those with normal baseline renal function. Performance of PCI independently predicted a lower in-hospital mortality among patients presenting with ACS, even in the presence of advanced CKD.

1. Gupta T, Paul N, Kolte D, Harikrishnan P, Khera S, Aronow WS, Mujib M, Palaniswamy C, Sule S, Jain D, Ahmed A, Cooper HA, Frishman WH, Bhatt DL, Fonarow GC, Panza JA. Association of chronic renal insufficiency with in-hospital outcomes after percutaneous coronary intervention. *J Am Heart Assoc* 2015;4(6):e002069.
2. Healthcare Cost and Utilization Project. National Readmission Database documentation, April 2017. Available at https://www.hcup-us.ahrq.gov/db/nation/nrd/nrddbdocumentation.jsp; accessed August 9, 2017.
3. Charytan D, Mauri L, Agarwal A, Servoss S, Scirica B, Kuntz RE. The use of invasive cardiac procedures after acute myocardial infarction in long-term dialysis patients. *Am Heart J* 2006;152(3):558–564.
4. Weisbord SD, Palevsky PM. Prevention of contrast-induced nephropathy with volume expansion. *Clin J Am Soc Nephrol* 2008;3(1):273–280.
5. 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.