Online Appendixes 1–5.
ACCF/AHA/SCAI 2013 Update of the Clinical Competence Statement on Coronary Artery Interventional Procedures

Online Appendix 1. Selective Reports Relating Institutional PCI Volume to Outcomes

Study	Data Source	No. of patients/ centers studied	Conclusions	Comments
Hartz et al. (1), 1992	1989–1991 Wisconsin Medicare	2,091/16	No relation between volume and outcome	Very low number of cases and hospitals examined
Ritchie et al. (2), 1993	1989 California State (Adm)	24,883/110	Increased CABG (not death) less than 20 cases per yr; finding is valid for both acute MI and non-acute MI patients	
Jollis et al. (3), 1994	1987–1990 MEDPAR (Adm)	217,836/1,194	Death and CABG increased with low volume (risk increases with Medicare patient volume* (<100–200 total per yr for death, 200–300 per yr for CABG)	
Kimmel et al.(4), 1995	1992–1993 SCAI	19,594/48	Fewer major complications for labs with >400 cases per yr	Risk-adjusted
Jollis et al. (5), 1997	1992 Medicare (Adm)	97,498/984	Incremental decrease in death and bypass surgery as hospital Medicare volume* <100, 100–200, >200 per yr	
Hannan et al. (6), 1997	1991–1994 NY State	62,670/31	Death and same stay CABG increased with annual caseloads <600	Risk-adjusted
Ho et al. (7), 2000	1984–1996 California, OSHPD database (Adm)	353,488/129	PTCA procedure volume (low volume <200 PCIs, intermediate volume	Risk-adjusted

Study	Data Source	No. of patients/ centers studied	Conclusions	Comments
			200-400 PCIs/yr, high-volume >400 PCIs/yr) significantly predicted in-hospital mortality and in-hospital CABG rates across 3 time periods	
Kimmel et al. (8), 2002	1994–1995 Pennsylvania Health Care Cost Containment Council database	25,222/43	Higher PCI volume (≥400) was associated with reduced in-hospital CABG No association between PCI volume and post-discharge CABG, revascularization, MI, or mortality.	Risk-adjusted < 25% stent use
Epstein et al. (9), 2004	1998-2000 The Agency for Healthcare Research and Quality's Nationwide In-patient Sample Hospital Discharge database	362,748 / 457	Compared with high-volume hospitals (400-999 cases/yr), patients treated in low-volume hospitals (5 to 199 cases/yr) remained at increased risk for mortality after multivariable adjustment. Patients treated in medium-(200-399 cases/yr) and very high-volume (≥1,000 cases /yr) hospitals had a comparable risk of mortality.	Risk-adjusted Hospitals were divided into low, medium (200-399 cases/yr), high, and very high (≥ 1,000 cases /yr) PCI volume hospitals
Moscucci et al. (10), 2005	1998–1999 NY State and MI	11,374/8	In-hospital death increased for hospital volume <400.	Risk-adjusted
Hannan et al. (11), 2005	1998–2000 NY State	107,713/34	Death, same-day CABG, same-stay CABG increased for hospital volume <400.	Risk-adjusted
Carey et al. (12), 2005	1999–2001 California OSHPD (Adm)	153,755 PCI procedures/ 138	PCI mortality in low-volume (<600/year) hospitals is	Risk-adjusted

Study	Data Source	No. of patients/ centers studied	Conclusions	Comments
			statistically significantly higher compared with that in high-volume (≥600/year) hospitals. No volume effect was noted for PCI mortality after risk-adjustment.	
Burton et al. (13), 2006	1997 - 2003 Cohort study of all PCIs undertaken in Scottish National Health Service hospitals. Scotland	17,417 PCI procedures / 6	No significant differences in the risk of 30-d and 2-year death or MI. No net difference in revascularization at 2 years. Patients treated in high-volume hospitals (>750 PCIs/yr) were less likely to require CABG at 30 days and 2 years.	Risk-adjusted
Allareddy et al. (14), 2007	2000 -2003 Nationwide Inpatient Sample of the Healthcare Cost and Utilization Project (representing a 20% stratified sample of community hospitals in the United States) (Adm)	573,072 PCI procedures /744	Hospitals not meeting the Leapfrog threshold for PCI (≥400 for PCI per year) had increased odds of in-hospital mortality 1.23 (95% CI:1.10 to 1.36).	Risk-adjusted
Zahn et al. (15), 2008	2003 PCI registry of all consecutive PCI procedures from an association of non-university centers Germany	27,965 / 67	PCI performed at hospitals with a volume of >325 PCI/yr was independently associated with a lower hospital mortality.	Risk-adjusted

Study	Data Source	No. of patients/ centers studied	Conclusions	Comments
Lin et al. (16), 2008	2003 Taiwan National Health Insurance Research Database and the Cause of Death Data File Taiwan	12,369 / 59	Low-volume PCI centers (<200 cases per year) had higher adjusted 30-d mortality compared with high-volume centers (≥400 PCIs/year). Medium- (200-399 PCIs/year) and high-volume centers (≥400 PCIs/year) had comparable 30-d mortality.	Risk-adjusted
Madan et al. (17), 2009	1999-2000 Substudy from the ESPRIT trial USA, Canada	1,338/ 57	Institutional volume was associated with a modest adjusted reduction in risk of death, MI or TVR at 30 days and one year The rates of 30-day and one-year death, MI or TVR fell by 3% for every 100 patients treated by the institution.	Risk-adjusted By multivariate modeling, operator volume was not predictive of adverse clinical events.

CABG indicates coronary artery bypass graft surgery; ESPRIT, CI, confidence interval; Enhanced Suppression of the Platelet glycoprotein IIb/IIIa Receptor with Integrilin Therapy trial; MEDPAR, Medicare Provider Analysis and Review; MI, myocardial infarction; OSHPD, Office of Statewide Health Planning and Development; PCI, percutaneous coronary intervention; PTCA, percutaneous transluminal coronary angioplasty; TVR, target vessell revascularization.

*Medicare patients usually constitute 35% to 50% of total interventional caseload.

Online Appendix 2. Stent-Era Evaluations of Associations between Operator Volume and Outcomes

Study	Data Source	No. of PCIs or patients undergoing PCI / Interventional operators Studied	Conclusions	Comments
Malenka et al. (18), 1999	1994-1996 Northern New England, US	15,080 PCIs / 47 operators	No significant relationship between operator volumes and outcomes.	High-volume centers defined as performing >600 PCIs/year).
McGrath et al. (19), 2000	1997 Medicare National Claims, US	167,208 patients / 6,534 operators (n=1003 hospitals)	After adjustment for case mix, patients treated by low-volume (<30 PCIs) operators had an increased risk of CABG compared with patients treated by high-volume (>60 PCIs) operators, but no differences in 30-day mortality were observed. Medicare patients treated by high-volume physicians at high-volume centers experienced the best outcomes following PCIs.	58% of PCI procedures involved coronary stents.
Harjai et al. (20), 2004	1999-2001 Beaumont, US	12,293 PCIs / 28 operators	Operator volume, experience, and board certification showed no univariate or multivariate relation with in-hospital mortality or the composite clinical end-point (death, CABG, MI or stroke).	The Beaumont PCI Risk Score showed a strong independent relation with outcomes, indicating that patients' clinical risk is the overriding determinant of clinical outcomes.
Hannan et al. (11), 2005	1998-2000 New York PCI Registry, US	107,713 patients / 263 operators (n=34 hospitals)	For an operator volume threshold of 75 PCIs/year, ORs for low- vs. high-volume operators were 1.65 (95% CI:1.05 to 2.60) for same-day CABG and 1.55 (95% CI:1.10 to 2.18) for same-stay	Risk-adjusted Higher-volume hospitals also experienced lower risk-adjusted of PCI outcome rates.

Study	Data Source	No. of PCIs or patients undergoing PCI / Interventional operators Studied	Conclusions	Comments
			CABG. Operator volume was not significantly associated with mortality.	
Mosucci et al. (21), 2005	2002 University of Michigan regional consortium	18,504 PCIs / 165 operators	Operators' volume was divided into quintiles (1-33, 34-89, 90-139, 140-206, and 207-582 PCIs/year). Patients treated by low-volume operators had a 63% increased odds of MACE (adjusted OR=1.63, 95% CI:1.29 to 2.06, for Q1 vs. Q5; adjusted OR=1.63, 95% CI:1.34 to 1.90, for Q2 vs. Q5), but no significant differences in-hospital mortality were observed.	Risk-adjusted Stent utilization >80% Although the relationship between operator volume and in-hospital mortality was no longer significant, the relationship between volume and any adverse outcome was still present.
Mustafa et al. (22), 2005	2000-2002 New Jersey, US	6,510 PCIs / 51 operators	After multivariable adjustment, low- and intermediate-volume operators were not significantly associated with major PCI complications (death, MI, coronary perforation, emergent CABG, and pericardial tamponade).	Two-center study 97% stent use
Cantor et al. (23), 2006	1995-2001 Ontario, Canada	38,561 PCIs / 65 operators (n=8 hospitals)	After stratifying operators by average annual PCI volume into low- (<155 cases), intermediate- (155-195 cases), and high-volume	These findings might be attributable to the high annual volumes of most operators and institutions in Ontario.

Study	Data Source	No. of PCIs or patients undergoing PCI / Interventional operators Studied	Conclusions	Comments
			(>195 cases), no significant linear relationships between risk-adjusted outcomes and operator tertiles existed.	
Minges et al. (24), 2011	2009 ACCF NCDR® National Cath Registry, US	345,526 PCI / 3,649 operators (n=543 hospitals)	In-hospital mortality was higher among physicians performing <75 PCIs/year compared with ≥75 PCIs/year (1.55 vs. 1.25%, p<0.001; adjusted OR=1.14, 95% CI:1.05 to 1.24). Higher rates of bleeding, emergency PCI, post-operative CABG, and longer mean length of stay were observed in lower-volume operators (<75 PCIs/year).	The correlation between in-hospital mortality and physician volume was only modest. The absolute differences in mortality were small and no apparent operator volume threshold existed.

ACCF indicates American College of Cardiology Foundation; CABG, coronary artery bypass graft surgery; CI, confidence interval; MACE, major adverse cardiac event; MI, myocardial infarction; NCDR®, National Cardiovascular Data Registry; OR, odds ratio; and PCI, percutaneous coronary intervention.

Online Appendix 3. Selective Published Reports Relating Hospital and Operator Primary PCI Volume after AMI to Outcomes

Study	Data Source	No. of patients (or PCIs)/ Hospitals studied	Conclusions	Comments
Tiefenbrunn et al. (25),	1994 - 1995 Second National Registry of MI (NRMI), US	4,939/?	Increased acute MI mortality for hospital <25 acute MI cases/year.	
Zahn et al. (26), 1997	1992–1995 German Hospital Consortium	4,625/?	For patients with acute MI: increased mortality in hospitals with ≤40 acute MI PCI/year.	No risk adjustment
Magid et al. (27), 2000	1994 -1999 National Registry of Myocardial Infarction (NRMI), US	62 299 AMI patients (21,973 patients undergoing PPCI) / 446	Only patients with AMI treated at hospitals with high- or intermediate- PPCI volumes had lower in-hospital mortality with PPCI than with thrombolysis. AMI patients treated at with low- volume PPCI hospitals had similar mortality outcomes with PPCI or thrombolysis.	Risk-adjusted Hospitals classified as low volume (≤16), intermediate volume (17-48), and high volume (≥49) based on their annual PPCI volume.
Canto et al. (28), 2000	1994-1998 National Registry of Myocardial Infarction (NRMI), US	257,602 / 450	Patients with acute MI who are treated at high-volume PPCI centers have a lower mortality rate than patients treated at low-volume centers. High-volume centers perform PPCIs faster.	Risk-adjusted Hospitals divided into quartiles according to PPCI hospital volume. No association between volume and mortality among patients treated with thrombolysis.
Cannon et al. (29), 2000	1994 -1998 National Registry of Myocardial Infarction (NRMI), US	27,080 / 661	A procedure volume >3 PPCIs/ month was associated with lower in-hospital mortality compared with a procedure volume <1 PPCI/ month or a procedure volume between 1	Risk-adjusted

Study	Data Source	No. of patients (or PCIs)/ Hospitals studied	Conclusions	Comments
			and 3 PPCIs/month.	
Vakili et al. (30), 2001	1995 New York State Coronary Angioplasty Reporting System Registry, US	1,342 / 32	A higher volume of PPCI procedures performed by physicians and/or hospitals was associated with lower in-hospital mortality rate.	Physicians and Hospitals were ranked according to terciles of annual PPCI volume. Risk-adjusted
Vakili et al. (31), 2003	1995 New York State Coronary Angioplasty Reporting System Registry, US	1,342 / 32	The annual total PCI volume of physicians (low- or high-volume) was not related to in-hospital mortality of patients with AMI treated with PPCI. An annual hospital volume >400 PCIs resulted in a 40% reduction in risk of in-hospital mortality for patients treated with PPCI for AMI.	Risk adjusted
Tsuchihashi et al. (32) , 2004	1997 Japanese nationwide registry, Japan	2,491 / 129	After multivariable adjustment, no significant relationships existed between volume and in-hospital mortality and need for CABG.	Risk-adjusted. Hospitals divided into terciles according to their median annual PCI volume for acute MI (low=10; medium=33; high=89).
Hannan et al. (11), 2005	1998–2000 NY State	107,713 / 34	Significantly higher odds of in-hospital mortality were observed in lower-volume hospitals (for all cutoffs used: 36, 40 or 60 PPCIs/year). Odds ratios for mortality were also elevated, although not	Risk-adjusted.

Study	Data Source	No. of patients (or PCIs)/ Hospitals studied	Conclusions	Comments
			significantly, for lower-volume operators in comparison with higher-volume operators (using volume cut offs at 8 or 10 PPCIs/year).	
Zahn et al. (33), 2005	1994 – 2000 Registry of PCIs in AMI (ALKK), Germany	4815 / 80	PPCI volume at the hospital was an independent predictor of in-hospital mortality.	Risk-adjusted
Spaulding et al. (34), 2006	2001 – 2002 CARDIO-ARIF Registry, France	37,848 PCIs (emergency and non-emergency procedures) / 44	In-hospital mortality was significantly lower in high-volume PCI center compared with low-volume centers among patients undergoing emergency procedures PCIs. No difference in mortality was noted between low- and high-volume PCI centers for non-emergency procedures.	Hospitals performing <400 PTCAs per year were classified as low-volume. Risk-adjusted.
Ohtsuka Machino et al. (35), 2008	2004 – 2006 Ibaraki Coronary Artery Disease Study (ICAS), Japan	401 / 11	No relationship between hospital PCI volume and in-hospital outcomes (death, CABG, repeat PCI).	High-volume center (>50 PPCIs/year). No risk adjustment.
Shiraishi et al. (36), 2008	2000-2005 AMI-Kyoto Multi-Center Risk Study database, Japan	2,230 / 16	Angiographic results of PPCI in high-volume hospitals were superior to those in low-volume hospitals. No differences observed in crude or adjusted in-hospital mortality in high- vs. low-volume centers.	Hospitals were classified into quintiles based on their annual PPCI volume. The fifth quintile of hospitals was labeled as high-volume, and the other quintiles combined were defined as low-volume.
Srinivas et al. (37), 2009	2000-2002 New York State PCI	7,321 / 41	High-volume PPCI hospitals (>50 cases/year) and high-volume PPCI physicians (>10	Risk-adjusted

Study	Data Source	No. of patients (or PCIs)/ Hospitals studied	Conclusions	Comments
	Registry, US		cases/year) were associated with lower odds of mortality compared with their respective low-volume counterparts. In-hospital mortality was greater when PPCI was performed by low-volume physicians in low-volume hospitals compared with high-volume physicians in high-volume hospitals. In high-volume hospitals, PPCI by low-volume physicians was associated with significantly worse outcomes compared with high-volume physicians.	
Kumbhani et al. (38), 2009	2001-2007 AHA GWTG Registry, US	29,513 / 166	No significant differences in crude or adjusted in-hospital mortality between tertiles of hospital PPCI volume. Compared with low-volume hospitals, high-volume hospitals have shorter DTB times, larger proportion of patients who achieve ACCF/AHA recommended DTB ≤90 minutes, and greater adherence with evidence-based therapies and recommendations. No differences adjusted mortality based on the total angioplasty volume of hospitals	Risk-adjusted Hospitals were divided into tertiles (< 36, 36-70, and >70 PPCIs/year) based on their annual PPCI volume.
Kuwabara et al. (39), 2011	2006	8,391 / 303	An inverse association was	Hospitals were divided into

Study	Data Source	No. of patients (or PCIs)/ Hospitals studied	Conclusions	Comments
	Retrospective analysis from hospitals implementing the Diagnostic Procedure Code, Japan (Adm)		found between PPCI volume and crude in-hospital mortality (p=0.016). After case-mix adjustment, a significant decrease in mortality for patients treated at high-volume (3rd, 4th quartile) compared to the lowest-volume (1st quartile) hospitals.	quartiles based on the number of PCI procedures per half-year (6-13, 14-22, 23-38, 39-134). Risk-adjusted.

ACCF indicates American College of Cardiology Foundation; AHA, American Heart Association; ALKK, Arbeitsgemeinschaft Leitender Kardiologischer Krankenhausarzte (Association of Leading Cardiological Hospital Physicians); AMI, acute myocardial infarction; CABG, coronary artery bypass graft surgery; DTB, door to balloon; MI, myocardial infarction; GWTG, Get With The Guidelines; NCDR®, National Cardiovascular Data Registry; NRMI, National Registry of Myocardial Infarction; PCI, percutaneous coronary intervention; PPCI, primary percutaneous coronary intervention; and PTCA, percutaneous transluminal coronary angioplasty.

Online Appendix 4. Recent Studies Comparing PCI with and without Onsite Cardiac Surgery

Study (year)	Design	Population (n)	Endpoints	Mortality	Other results	Conclusion
SCAAR (2007) (40)	Registry of all PCIs in country	Elective = 28911 STEMI = 5452	30-day mortality, 1-year mortality, Emergency CABG	Elective On site surgery = 0.2% No onsite surgery = 0.4% Primary PCI On site surgery = 6.7% No onsite surgery = 7.0%	Emergency CABG On site surgery = 0.2% No onsite surgery = 0.1% (p=0.025)	No difference in 30-day mortality, 1-year mortality, stroke or emergency CABG between groups
Singh (2009) (41)	Matched case-controlled	Elective = 1842 Non-elective = 667	In-hospital mortality, Emergency CABG, MACE*	Elective On site surgery = 0.4% No onsite surgery = 0.2% Non-elective On site surgery = 3.1% No onsite surgery = 2.5%	Emergency CABG Elective On site surgery = 0.2% No onsite surgery = 0% Non-elective On site surgery = 0.7% No onsite surgery = 0.6%	In-hospital mortality and MACE not different for elective and non-elective patients at sites with and without onsite surgery. Emergency CABG higher for elective patients at sites with onsite surgery
Kutcher (2009) (42)	NCDR® Registry	Elective = 275114 Non-elective = 33033	In-hospital mortality, Emergency CABG	Non-primary PCI Onsite surgery = 0.8% No onsite surgery = 0.8% Primary PCI Onsite surgery = 5.2% No onsite surgery = 5.1%	Emergency CABG Non-primary PCI Onsite surgery = 0.3% No onsite surgery = 0.2% Primary PCI Onsite surgery = 1.2% No onsite surgery = 0.7%	Sites without onsite surgery had similar procedure success, in-hospital mortality and emergency CABG rates.
Singh (2011) (43)	Meta-analysis of 15 studies	Non-primary = 914288 Primary = 124074	In-hospital mortality, Emergency CABG	Non-primary PCI Onsite surgery = 0.8% No onsite surgery = 0.9% Primary PCI Onsite surgery = 5.1% No onsite surgery = 4.6%	Emergency CABG Non-primary PCI Onsite surgery = 0.29% No onsite surgery = 0.17% Primary PCI Onsite surgery = 1.03% No onsite surgery = 0.22%	STEMI patients: Mortality and emergency CABG not different. Non-primary patients: Overall, emergency CABG and mortality not different, but after adjustment for publication bias, mortality 25% higher at sites without surgery.

Study (year)	Design	Population (n)	Endpoints	Mortality	Other results	Conclusion
Zia (2011) (44)	Meta-analysis of 11 studies	Non-primary = 909,813 Primary = 105,993	In-hospital mortality, Emergency CABG	Non-primary PCI Onsite surgery = 2.1% No onsite surgery = 1.6% Primary PCI Onsite surgery = 7.6% No onsite surgery = 6.1%	Emergency CABG Non-primary PCI Onsite surgery = 0.9% No onsite surgery = 1.0% Primary PCI Onsite surgery = 3.4% No onsite surgery = 3.0%	Sites without onsite surgery were not associated with higher in-hospital mortality or emergency CABG. Substantial hospital variability in outcomes for non-primary PCI
CPORT-E (2012) (45)	Randomized	Elective only	6-week mortality, 9 month MACE†	Onsite surgery = 1.0% No onsite surgery = 0.9%	9-month MACE Onsite surgery = 11.2% No onsite surgery = 12.1%	PCI at hospitals without onsite surgery was not inferior to sites with onsite surgery

CABG indicates coronary artery bypass graft surgery; CPORT-E, Cardiovascular Patient Outcomes Research Team (CPORT) Non-Primary PCI (CPORT-E); MACE, major adverse cardiac events; NCDR®, National Cardiovascular Data Registry; PCI, percutaneous coronary intervention; SCAAR, Swedish Coronary Angiography and Angioplasty Registry; and STEMI, ST-segment elevation myocardial infarction.

*MACE defined as in-hospital death, q-wave MI, urgent, emergent CABG, stroke

†MACE defined as death, target vessel revascularization, Q-wave myocardial infarction

Online Appendix 5. A Summary of Contemporary PCI Risk Scores and Predictive Models

Study	Data Source	No. of PCI procedures (derivation/validation cohorts)	Primary independent variable	Predictors
Weintraub et al. (46), 2012	2004 and 2007 The ACCF NCDR® CathPCI Registry and the Centers for Medicare and Medicaid Services Database, USA	n=343,466 patients (Randomly divided into 60% derivation and 40% validation cohorts).	3-year mortality in elderly patients (≥65 yo) after PCI	Mortality rates were: 3% at 30 days; 9% at 1 year; 13% at 2 years, and 19% at 3 years. A model predicting mortality up to 3 years after PCI included 24 characteristics (related to demographics, comorbidity, prior medical history, and indices of disease severity and acuity).
de Mulder et al. (47), 2011	2005-2008 The Euro Heart Survey of PCIs	Training cohort: n = 23,032 patients. Validation cohort: n = 23,032 patients.	In-hospital mortality after PCI	In-hospital mortality: 1.3% (validation cohort) A logistic model of 16 independent patient/lesion characteristics was constructed (including PCI indication, age, hemodynamic instability, multivessel CAD, proximal LAD disease). Excellent discrimination (C-index: 0.90) in validation cohort
Peterson et al. (48), 2010	2004-2006 The ACCF NCDR® CathPCI Registry, USA	Derivation cohort: 181,775 PCI procedures from 2004 to 2006. 2 validation cohorts: (a) contemporary (n=121,183); 2004 - 2006. (b) Prospective (n=285,440 PCIs); March 2006- March 2007.	In-hospital mortality after PCI	In-hospital mortality: 1.3% (0.7% in elective PCI; 4.8% after STEMI). A simplified NCDR® risk score was developed based on 8 key pre-procedure factors. Excellent discrimination (c-index: 0.91). Discrimination and calibration were retained among specific patient subgroups, and when used to estimate 30-day mortality rates among Medicare patients.
Hamburger et al. (49), 2009	2000-2005 The British Columbia Cardiac Registry (BCCR)	Patients (total n=32,899) were divided into: (a) Training cohort (n=26,350; 2000-2004). (b) Validation cohort (n=6,549; 2005)	30-day mortality after PCI	30-d mortality: 1.5% Area under the ROC curve: 91.1% (validation set)
Mehta et al. (50), 2009	The ACCF NCDR® CathPCI Registry, USA	302,152 PCI procedures performed at 440 US centers participating in	Bleeding risk after PCI	Bleeding complications occurred in 2.4% of patients.

Study	Data Source	No. of PCI procedures (derivation/validation cohorts)	Primary independent variable	Predictors
		the NCDR® Registry (80% population sued as training cohort; validation done in 20% of population and subgroups).	PCI bleeding complications defined as (bleeding required transfusion, prolonged LOS, drop in Hb >3.0 g/dL)	A parsimonious risk algorithm was developed, including the following predictors of bleeding: age, gender, previous HF, GFR, PAD, no previous PCI, class IV HF, STEMI, NSTEMI, cardiogenic shock.
Brown et al. (51), 2008	2003 - 2005 Northern New England, USA	n=11,141 patients (derivation cohort) undergoing PCI without dialysis in northern New England	SRD after PCI (defined as new dialysis, ≥2.0 mg/dL or ≥50% increase in creatinine)	SRD occurred in 0.74% of patients. SRD was associated with in-hospital mortality of 19.3% versus 0.9% in those without SRD. A risk model included: Preprocedural creatinine, CHF, DM, accounted, urgent/emergent PCI, IABP, age ≥ 80 yo, sex. Validation on 2006 PCI procedures demonstrated excellent discrimination (area under ROC curve: 0.84)
Chowdhary et al. (52), 2009	2000-2008 The Toronto PCI registry	Derivation cohort: 10,694 patients. Validation cohort: 5,347 patients.	In-hospital mortality after PCI	In-hospital mortality: 1.3%. Independent predictors with associated risk weights in parentheses were as follows: age, DM, diabetes, RF, NYHA class IV HF, LVEF, MI in prior mo, multivessel CAD, LM-CAD, rescue/ facilitated PCI, primary PCI, shock. The model had an area under the ROC curve: 0.96
Singh et al. (53), 2007	2000-2005 The Mayo Clinic Registry	Analysis population: 9,035 PCIs on 7640 unique patients from 2000 through 2005.	In-hospital mortality after PCI In-hospital MACE after PCI	7 simple clinical and noninvasive variables, available before coronary angiography, (age, MI within 24 h, preprocedural shock, Cr level, LVEF, CHF, PAD). Excellent discrimination (areas under the ROC curve were 0.74 and 0.89 for MACE and procedural death, respectively) Validation of the Mayo risk score for in-hospital mortality was subsequently undertaken in a cohort of 309,351 patients from the NCDR® Registry (2004 - 2006).
Wu et al. (54),	2002-2003	Derivation cohort:	In-hospital mortality for PCI	Risk score included 9 significant risk factors (age,

Study	Data Source	No. of PCI procedures (derivation/validation cohorts)	Primary independent variable	Predictors
2006	the New York State PCI Registry	46,090 procedures performed in 41 hospitals in the NY State PCI Registry in 2002 Validation cohort: Data from the 2003 New York Registry		gender, hemodynamic state, EF, pre-procedural MI, PAD, CHF, RF, LM-CAD) The risk score for mortality was strongly associated with complication rates and LOS.

ACCF indicates American College of Cardiology Foundation; CAD, coronary artery disease; CHF, Congestive Heart Failure; Cr, creatinine; DM, diabetes mellitus; GFR, glomerular filtration rate; Hb, hemoglobin; HF, heart failure; IABP, intra-aortic balloon pump; LAD, left anterior descending; LM-CAD, left-main coronary artery disease; LOS, length of stay; LVEF, left ventricular ejection fraction; MACE, major adverse cardiac events; MI, myocardial infarction; NCDR®, National Cardiovascular Data Registry; NSTEMI, non-ST segment elevation myocardial infarction; NYHA, New York Heart Association; PAD, peripheral arterial disease; PCI, percutaneous coronary intervention; PAD, peripheral arterial disease; RF, renal failure; ROC, receiver operating characteristic; SRD, serious renal dysfunction; and STEMI, ST segment elevation myocardial infarction.

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