Journal of Interventional and General Cardiology

Patel, et al., J Interv Gen Cardiol 2018, 2:2

Research Article Open Access

Can Non-procedural Patient Characteristics Predict In-hospital Complications Following Elective Percutaneous Coronary Intervention? Implications for Same-Day Discharge

Gaurav Patel[1]*, Sukrut Nanavaty[2], John Coppola[3], Tak Kwan[4], Tejas Patel[5] and Samir Pancholy[1]

[1]*Division of Cardiology, The Wright Center for Graduate Medical Education, Scranton, Pennsylvania, USA*

[2]*Division of Cardiology, Geisinger Holy Spirit, Camp Hill, Pennsylvania, USA*

[3]*Division of Cardiology, New York University Medical Center, New York, New York, USA*

[4]*Division of Cardiology, Beth Israel Medical Center, New York, New York, USA*

[5]*Division of Cardiology, Apex Heart Institute, Ahmedabad, India*

***Corresponding author:** Patel G, Division of Cardiology, The Wright Center for Graduate Medical Education, Scranton, Pennsylvania, USA, Tel: +1-570-343-2383; E-mail: patelg@thewrightcenter.org

Received date: September 25, 2018; **Accepted date:** September 28, 2018; **Published date:** October 04, 2018

Abstract

Objectives: To identify non-procedural predictors of in-hospital complications following elective percutaneous coronary interventions (PCIs).

Methods: Using the Nationwide Inpatient Sample (NIS) data from 1998-2013, we identified patients 18 years of age and older who were electively admitted for PCI. Post-PCI complications were defined as the occurrence of any of the following: acute cerebrovascular accident, acute kidney injury, vascular complications and blood transfusion, iatrogenic cardiac complications, cardiogenic shock, cardiac arrest or in-hospital mortality. Post-PCI same-day discharges (SDDs) were identified. Binary logistic regression was used to identify the independent predictors of post-PCI complications. Receiver Operating Characteristic (ROC)-derived Area under the Curve (AUC) was used to determine the discriminatory power of the model.

Results: We identified 373,223 patients who were electively admitted for PCI as the index procedure. 18,430 patients (4.9%) developed post-PCI complications. Several covariates showed a statistically significant association with post-PCI complications [(O.R., 95% CI, P-value), age (1.009, 1.007-1.010, 0.0005), female sex (1.465, 1.421-1.511, 0.0005), hypertension (1.172, 1.094-1.255, 0.0005), congestive heart failure (1.139, 1.080-1.200, 0.0005), diabetes with end-organ damage (1.145, 1.057-1.241, 0.001), atrial fibrillation (1.515, 1.437-1.596, 0.0005), atrial flutter (1.438, 1.215-1.701, 0.0005), morbid obesity (1.216, 1.089-1.358, 0.001), chronic kidney disease (1.099, 1.008-1.199, 0.032) and Charlson comorbidity index (1.229, 1.216-1.244, 0.0005)], although the model was a poor-fit with suboptimal discriminatory power (ROC-derived AUC=0.6).

Conclusion: Non-procedural variables lack the ability to predict short-term adverse outcomes following elective PCI and probably should not be used in decision-making for SDD following PCI.

Keywords: Same-day discharge; Percutaneous coronary intervention; In-hospital outcomes

Introduction

The feasibility of percutaneous coronary intervention (PCI) in complex substrate of population has increased over the previous decade. With technological advancement in stenting, increasing expertise, better antithrombotic agents and widely use of radial access, PCI-related abrupt vessel closure, acute stent thrombosis, and access site vascular complications have decreased [1,2]. PCI can now be performed in the ambulatory settings in stable patients as a "same-day" procedure [3]. Compared to overnight observation, same-day discharge (SDD) after PCI is associated with lower post-procedural complications, leading to lower healthcare costs and better patient satisfaction [4-9]. The utility of non-procedural patient characteristics in predicting post-PCI adverse events in this subset of patients has not been systematically evaluated and may allow the operators to identify high-risk patients and can guide in the decision-making for SDD. We sought to analyze the non-procedural patient characteristics in predicting in-hospital complications following elective PCI from the Nationwide Inpatient Sample (NIS).

Materials and Methods

The NIS database

The NIS database, developed and managed by the Agency for Healthcare Research and Quality (AHRQ) Healthcare Cost and Utilization Project (HCUP), is the largest, all-payer database in the United States. Prior to 2012, the NIS represents 20% stratified sample of all community and nonfederal US hospitals [10]. From 2012, the NIS was significantly redesigned to represent 20% stratified discharges of all community US hospitals [11]. The NIS contains information on

each individual hospitalization in the form of International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes and Clinical Classification Software (CCS) codes for all diagnoses and procedures.

Study population

From January 1998 through December 2013, hospitalizations with PCI as the primary procedure were selected by searching for the ICD-9-CM codes for PCI (00.66, 17.55, 36.0, 36.01, 36.02, 36.05, 36.06, 36.07, and 36.09). All patients electively admitted for the PCI with PCIs performed on the same day of the hospitalization were identified using the recorded information on admission type in the NIS dataset and were included in the analysis. We included all procedures performed in patients 18 years of age and older in the analyses. Figure 1 demonstrates data extraction and patient selection methods.

Definitions and outcomes

The primary study outcome measure was post-PCI complications in patients electively admitted for the procedure. By using the ICD-9-CM and CCS codes provided in the NIS dataset, we defined post-PCI complications as the occurrence of any of the following: acute cerebrovascular accident (ACVA), acute kidney injury (AKI), vascular complications and blood transfusion, iatrogenic cardiac complications, cardiogenic shock, cardiac arrest or in-hospital mortality. Discharges after PCIs were considered as SDDs if the length of hospitalization in days was zero in the absence of in-hospital mortality. Comorbidities were identified based on Elixhauser methods using standard AHRQ variables [12]. Patients' diagnoses were identified by using the ICD-9-CM diagnoses codes and CCS codes demonstrated in Table 1.

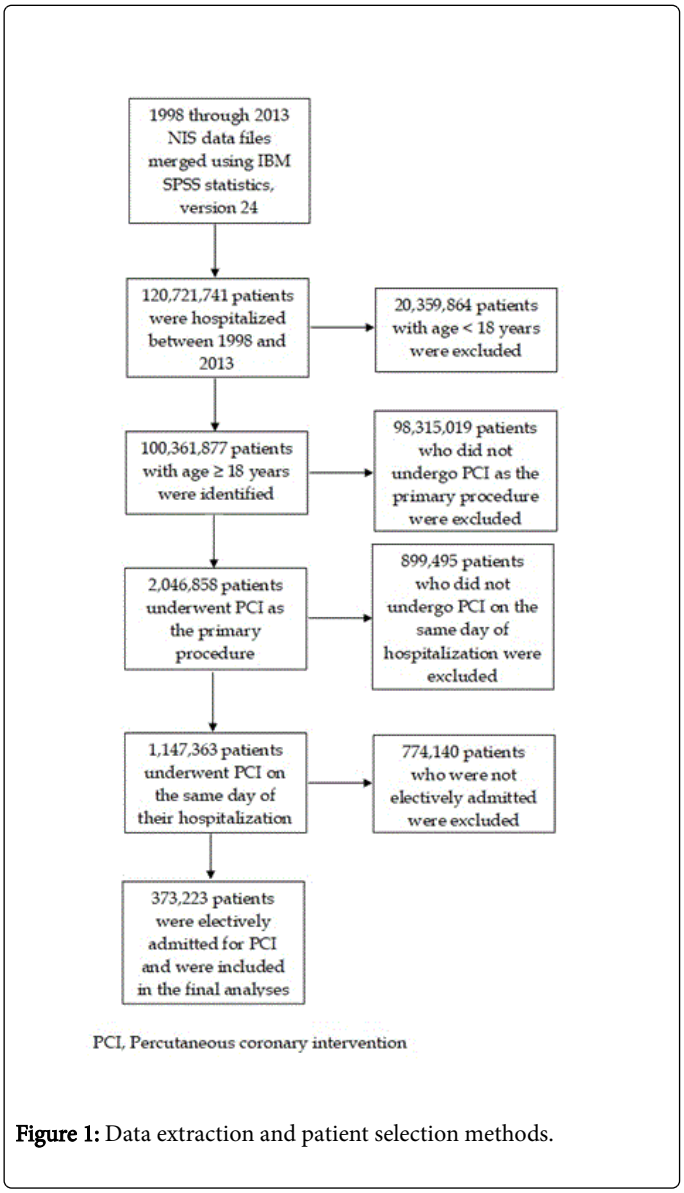

Figure 1: Data extraction and patient selection methods.

Comorbidities	ICD-9-CM codes	CCS codes
Acute cerebrovascular accident		109
Old cerebrovascular accident		113
Diabetes mellitus		
Without end-organ damage	250-250.33	
With end-organ damage	250.4-250.93	
Hypertension		
Without complications		98
With complications		99
Congestive heart failure	398.91, 402.01, 402.11, 402.91, 404.01, 404.11, 404.91, 428.0, 428.1, 428.2, 428.20, 428.21, 428.22, 428.23, 428.3, 428.30, 428.31, 428.32, 428.33, 428.4, 428.40, 428.41, 428.42, 428.43, 428.9	
Peripheral vascular disease	440, 440.0, 440.1, 440.2, 440.20, 440.21, 440.22, 440.23, 440.24, 440.29, 440.3, 440.30, 440.31, 440.32, 440.4, 440.8, 440.9, 441, 441.0, 441.00, 441.01, 440.02, 441.03, 441.1, 441.2, 441.3, 441.4, 441.5, 441.6, 441.7, 441.9, 442, 442.0, 442.1, 442.2, 442.3, 442.8, 442.81, 442.82, 442.83, 442.84, 442.89, 442.9, 443, 443.0, 443.1, 443.2, 443.21, 443.22, 443.23, 443.24, 443.29, 443.8, 443.81, 443.82, 443.89, 443.9, 447.1, 557.1, 557.9	
Chronic kidney disease		158
Cardiac arrest		107
Vascular complications		
Hemorrhage requiring transfusion		222
Vascular injury	Injury to blood vessels: 900-904	
	Accidental puncture: 998.2	
	Arteriovenous fistula: 447	
	Injury to retroperitoneum: 868.04	
	Vascular complications requiring surgery: 39.31, 39.41, 39.49, 39.52, 39.53, 39.56, 39.57, 39.58, 39.59, 39.79	
	Other vascular complications: 999.2, 997.7	
Iatrogenic cardiac complications	997.1	
Atrial fibrillation	427.31	
Atrial flutter	427.32	
Overweight	278.02	
Obesity	278.00	
Morbid obesity	278.01	

Table 1: International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) and Clinical Classification Software (CCS) codes used to identify comorbidities.

Statistical analysis

Patient and hospital-specific variables were included in the analysis. Baseline and hospital characteristics of patients developing post-PCI complications were compared. Continuous variables were expressed as means or medians as appropriate; categorical variables were expressed as proportions. To compare baseline characteristics between the two groups, Student t-test was used for continuous variables and Pearson chi-square test was used for categorical variables. A 2-sided p-value of < 0.05 was considered statistically significant. We created a binary logistic regression model to identify the independent predictors of post-PCI complications. The statistical significance of the model was determined by the Receiver Operating Characteristic (ROC)-derived Area Under the Curve (AUC). All the analyses were conducted using SPSS statistics, version 24 (IBM Corporation, Armonk, NY).

Results

Out of a total of 120,721,741 patients who were hospitalized between 1998 and 2013, 100,361,877 patients ≥ 18 years of age were extracted and included in the analysis. 2,046,858 patients underwent PCI as the primary procedure, of which, 1,147,363 underwent PCI on the same day of the hospitalization. A total of 373,223 patients were electively admitted to receive PCIs and were included in the final analysis. The rates of post-PCI complications were as follows: ACVA (0.1%), AKI (0.5%), vascular complications and blood transfusion (3.1%), iatrogenic cardiac complications (1.3%), cardiogenic shock (0.1%), cardiac arrest (0.3%) or in-hospital mortality (0.1%). A total of 18,430 patients (4.9%) developed post-PCI complications.

Patients developing post-PCI complications (Table 2) were more likely to be female (42.6% vs. 32.2%, P=0.0005), of advanced age (67 years vs. 65 years, P=0.0005), with history of previous cerebrovascular accident (0.7% vs. 0.5%, P=0.014), hypertension (9.5% vs. 4.9%, P=0.0005), atrial fibrillation (AF) (10.0% vs. 5.8%, P=0.0005), atrial flutter (AFl) (0.9% vs. 0.4%, P=0.0005), congestive heart failure (CHF) (10.8% vs. 6.1%, P=0.0005), peripheral vascular disease (PVD) (13.8% vs. 9.6%, P=0.0005), chronic kidney disease (CKD) (6.0% vs. 2.5%, P=0.0005), diabetes with end-organ damage (4.4% vs. 2.1%, P=0.0005) and morbid obesity (1.9% vs. 1.4%, P=0.0005). Charlson comorbidity index was significantly higher in patients developing post-PCI complications (1.41 vs. 0.9, P=0.0005), incurred significantly higher hospital charges ($\$4.6 \times 10^4$ vs. $\$3.4 \times 10^4$, P=0.0005) and had higher length of stay (2.68 days vs. 1.19 days, P=0.0005). Age, gender, hypertension, CHF, diabetes with end organ damage, AF, AFl, morbid obesity, CKD and Charlson comorbidity index were included in the multi-variate analysis.

Characteristics	Post-PCI complications		P-value
	Yes (n=18,430)	No (n=354,793)	
Age (Mean ± SD)	67.30 ± 11.0	65.34 ± 11.0	0.0005
Female (%)	42.6	32.2	0.0005
Race (%)			
White	85.0	83.6	0.001
Black	5.3	5.6	
Hispanic	5.2	6.0	
Asian or Pacific Islander	1.2	1.3	
Native American	0.3	0.3	
Other	3.1	3.1	
Old cerebrovascular accident (%)	0.7	0.5	0.014
Hypertension (%)	9.5	4.9	0.0005
Atrial fibrillation (%)	10.0	5.8	0.0005
Atrial flutter (%)	0.9	0.4	0.0005
Congestive heart failure (%)	10.8	6.1	0.0005
Peripheral vascular disease (%)	13.8	9.6	0.0005
Diabetes without end-organ damage (%)	25.9	28.2	0.0005
Diabetes with end-organ damage (%)	4.4	2.1	0.0005
Chronic kidney disease (%)	6.0	2.5	0.0005
Overweight (%)	0.1	0.2	0.196

Obese (%)	6.4	6.4	0.808
Morbidly obese (%)	1.9	1.4	0.0005
Total charges ($ x 104)	4.60 ± 4.07	3.40 ± 2.13	0.0005
Length of stay (Days)	2.68 ± 3.4	1.19 ± 0.87	0.0005
Charlson score (Mean ± SD)	1.41 ± 1.57	0.9 ± 1.18	0.0005
PCI: Percutaneous Coronary Intervention; SD: Standard Deviation			

Table 2: Baseline characteristics of the study population.

Independent predictors of post-PCI complications (Table 3) (O.R., 95% CI, P-value) were age (1.009, 1.007-1.010, 0.0005), female sex (1.465, 1.421-1.511, 0.0005), hypertension (1.172, 1.094-1.255, 0.0005), CHF (1.139, 1.080-1.200, 0.0005), diabetes with end-organ damage (1.145, 1.057-1.241, 0.001), AF (1.515, 1.437-1.596, 0.0005), AFl (1.438, 1.215-1.701, 0.0005), morbid obesity (1.216, 1.089-1.358, 0.001), CKD (1.099, 1.008-1.199, 0.032) and Charlson comorbidity index (1.229, 1.216-1.244, 0.0005). The model was likely over-fitted with ROC-derived AUC=0.6, indicating poor discriminatory power.

Independent variable	**In-hospital complications**	
	OR (95% CI)	**P-value**
Age	1.009 (1.007-1.010)	0.0005
Female	1.465 (1.421-1.511)	0.0005
Hypertension	1.172 (1.094-1.255)	0.0005
Congestive heart failure	1.139 (1.080-1.200)	0.0005
Diabetes with end-organ damage	1.145 (1.057-1.241)	0.001
Atrial fibrillation	1.515 (1.437-1.596)	0.0005
Atrial flutter	1.438 (1.215-1.701)	0.0005
Morbid obesity	1.216 (1.089-1.358)	0.001
Chronic kidney disease	1.099 (1.008-1.199)	0.032
Charlson comorbidity index	1.229 (1.216-1.244)	0.0005
OR: Odds ratio; CI: Confidence interval		

Table 3: Independent predictors of in-hospital complications.

Discussion

Our results of the Nation's largest, observational, real-world population dataset indicate that non-procedural patient characteristics do not predict post-procedural adverse outcomes in patients electively admitted to receive PCI.

Historically, overnight observation for 24 hours has been considered the standard practice in the United States for patients undergoing elective PCI [4] with reluctance on the part of operators to embrace SDD despite literature corroborating its safety [4-9]. In a multicenter cohort study from CathPCI Registry evaluating the prevalence and outcomes of SDD after elective PCI [4], SDD occurred in about 1.25% of the population. Studies have reported that significant complications of elective PCI occur within 6 hours of the procedure [8,9,13,14]. Several randomized clinical trials have compared the safety of SDD with overnight observation in patients undergoing elective PCI [4-9]. Bleeding complications have been a concern in patients undergoing PCI via transfemoral access; however, several randomized clinical studies have compared SDD to overnight observation in patients undergoing PCI via transfemoral access and found no significant difference in outcomes between the two groups [6,15]. Findings of the results of these studies were further corroborated by a recently published meta-analysis comparing SDD to overnight observation [16]. No significant difference in mortality, post-procedural myocardial infarction, and target lesion revascularization were noted between the two groups, indicating safety and feasibility of SDD in these patients. SDD after elective PCI procedure has been shown to reduce the cost of hospitalization [7,17]. Several studies have reported higher patient satisfaction rates with SDD compared to overnight hospital stay following elective PCI, indicating acceptance of these patients to SDD [4-9,15,16,18]. These findings could largely be explained by the availability of newer generation stents, advancement in procedure techniques including increasing adoption of transradial technique, and

widespread use of novel antithrombotic and anticoagulant medications.

Reluctance to adopt SDD is largely a result of poor understanding of the predictors of post-PCI complications. The results of our analysis suggest that patient demographics and comorbidities lack adequate value in predicting post-PCI complications, suggesting the predominant role of procedural metrics in predicting short-term (<24 hours) post-PCI outcomes. As hospitalization-related iatrogenic complications are more common in the elderly patients with chronic comorbid illnesses [1,19], these findings may allow the operator to extend the benefit of SDD to these patients with "pristine" post-PCI angiographic results, short procedure times with low volume of administered radiocontrast and access-site choice associated with low complications, regardless of their comorbidities or demographics, further improving their outcomes.

The anticipated results of the "Patient Satisfaction and Safety Outcomes After Enrollment in a Same-Day (SD) Percutaneous Coronary Intervention Program" (NCT01276132) [20], which is currently recruiting adult patients (≥ 18 years) undergoing outpatient PCI, will provide further definitive direction in this regard.

Study Limitations

The results of our analysis are limited by the observational nature of the study. The NIS dataset is an administrative database, which is subject to coding error. Since individual entry in the NIS provides information on single hospital discharge, long-term clinical outcomes could be studied. Lack of information on procedural characteristics, such as catheter size, use of peri-procedural medications, and information on access-site, exposes the results to confounding caused by these missing variables; however, due to the large sample size, the effect of unmeasured confounders is likely minimized.

Conclusion

Patient demographics and comorbidities do not predict adverse outcomes in patients undergoing elective PCI and these factors should not be used in the decision-making for SDD. Hospitals should develop a framework and encourage SDD in patients with favorable angiographic outcomes following elective PCI in view of established safety to improve healthcare resources utilization and patient satisfaction.

References

1. Rao SV, Hess CN, Dai D, Green CL, Peterson ED, et al. (2013) Temporal trends in percutaneous coronary intervention outcomes among older patients in the United States. Am Heart J 166: 273-281.
2. Subherwal S, Peterson ED, Dai D, Thomas L, Messenger JC, et al. (2012) Temporal trends in and factors associated with bleeding complications among patients undergoing percutaneous coronary intervention: A report from the National Cardiovascular Data Cath PCI Registry. J AmColl Cardiol 59: 1861-1869.
3. Chambers CE, Dehmer GJ, Cox DA, Harrington RA, Babb JD, et al. (2009) Defining the length of stay following percutaneous coronary intervention: An expert consensus document from the Society for Cardiovascular Angiography and Interventions. Catheter Cardiovasc Interv 73: 847-858.
4. Rao SV, Kaltenbach LA, Weintraub WS, Roe MT, Brindis RG, et al. (2011) Prevalence and outcomes of same-day discharge after elective percutaneous coronary intervention among older patients. JAMA 306: 1461-1467.
5. Ziakas AA, Klinke BP, Mildenberger CR, Fretz DE, Williams EM, et al. (2003) Safety of same-day-discharge radial percutaneous coronary intervention: A retrospective study. Am Heart J 146: 699-704.
6. Kim M, Muntner P, Sharma S, Fretz DE, Williams EM, et al. (2013) Assessing patient-reported outcomes and preferences for same-day discharge after percutaneous coronary intervention: results from a pilot randomized, controlled trial. Circ Cardiovasc Qual Outcomes 6: 186-192.
7. Heyde GS, Koch KT, deWinter RJ, Dijkgraaf MG, Klees MI, et al. (2007) Randomized trial comparing same-day discharge with overnight hospital stay after percutaneous coronary intervention: results of the Elective PCI in Outpatient Study (EPOS). Circulation 115: 2299-2306.
8. Jabara R, Gadesam R, Pendyala L, Chronos N, Crisco LV, et al. (2008) Ambulatory discharge after transradial coronary intervention: preliminary US single-center experience (Same-Day TransRadial Intervention and Discharge Evaluation, the STRIDE Study). Am Heart J 156: 1141-1146.
9. Small A, Klinke P, Della Siega A, Fretz E, Kinloch D, et al. (2007) Day procedure intervention is safe and complication free in higher risk patients undergoing transradial angioplasty and stenting: The DISCHARGE Study. Catheter Cardiovasc Interv 70: 907-912.
10. Healthcare Cost and Utilization Project (HCUP) 2011.
11. HCUP National Inpatient Sample (NIS)-Healthcare Cost and Utilization Project (HCUP) 2012.
12. Elixhauser A, Steiner C, Harris DR, Coffey RM (1998) Comorbidity measures for use with administrative data. Med Care 36: 8-27.
13. Jozic J, Orford J, Steinhubl S, Berger P, Hsu A, et al. (2008) Timing and correlates of very early major adverse clinical events following percutaneous coronary intervention. J Invasive Cardiol 20: 113-118.
14. Thel MC, Califf RM, Tardiff BE (2000) Timing of and risk factors for myocardial ischemic events after percutaneous coronary intervention. Integrilin to Minimize Platelet Aggregation and Coronary Thrombosis (IMPACT-II). Am J Cardiol 85: 427-434.
15. Carere RG, Webb JG, Buller CE, Rahman T, Spinelli J, et al. (2000) Suture closure of femoral arterial puncture sites after coronary angioplasty followed by same-day discharge. Am Heart J 139: 52-58.
16. Abdelaal E, Rao SV, Gilchrist IC, Bernat I, Shroff A, et al. (2013) Same-day discharge compared with overnight hospitalization after uncomplicated percutaneous coronary intervention: a systematic review and meta-analysis. JACC Cardiovasc Interv 6: 99-112.
17. Rinfret S, KennedyWA, Lachaine J, Lemay A, Rodés-Cabau J, et al. (2010) Economic impact of same-day home discharge after uncomplicated transradial percutaneous coronary intervention and bolus-only abciximab regimen. JACC Cardiovasc Interv 3: 1011-1019.
18. Shroff A, Kupfer J, Gilchrist IC, Caputo R, Speiser B, et al. (2016) Same-day discharge after percutaneous coronary intervention current perspectives and strategies for implementation. JAMA Cardiol 1: 216-223.
19. Rao SV, Dai D, Subherwal S, Weintraub WS, Brindis RS, et al. (2012) Association between periprocedural bleeding and long-term outcomes following percutaneous coronary intervention in older patients. J Am Coll Cardiol Intv 5: 958-965.
20. University of Chicago (2000) Patient satisfaction and safety outcomes after enrollment in a Same-Day (SD) Percutaneous Coronary Intervention Program. National Library of Medicine (US).