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Impact of Percutaneous Coronary Intervention on in Hospital Mortality in Cardiac Arrest – A National Perspective

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Abstract

Objective of our study was to find out survival benefit of performing percutaneous coronary intervention (PCI) in patients with cardiac arrest. The study population was derived from the nationwide inpatient sample (NIS) database from 2008 to 2012. Cardiac arrest, ventricular fibrillation (Vfib), ventricular tachycardia (Vtach), asystole/pulseless electrical activity (PEA) and ST elevation myocardial infarction (STEMI) were identified using appropriate international classification of disease (ICD-9) diagnostic codes and PCI was identified using appropriate ICD-9 procedural code. The primary endpoint was in-hospital mortality. Multivariate analysis (odds ratio , 95% confidence interval, p value) showed increased mortality with older age (1.01, 1.01-1.02, p<0.001), higher comorbidities indicated by Charlson score (CCI) ≥ 2 (1.08, 104-1.18, p<0.001)as compare to CCI of 0, STEMI (1.44, 1.38-1.51, p<0.001), Shock (1.66, 1.61-1.71, p<0.001), self-pay/uninsured (1.48, 1.40-1.56, p<0.001) as compare to Medicare/Medicaid, admission on weekends (1.17,1.14 -1.20, p<0.001) as compared to admission during weekdays. While PCI (0.24, 0.23-0.25, p<0.001), higher socioeconomic status (SES) (0.86, 0.82-0.89, p<0.001) as compare to lower SES, private insurance (0.89, 95%CI: 0.86-0.92, p<0.001) as compared to Medicare/Medicaid, teaching hospitals (0.96, 0.90-0.99, p-0.016) as compared to non-teaching hospitals were associated with decreased mortality. Hospital located in the west region (1.08, 1.01 to 1.16, p=0.024) as compared to hospitals located in northeast region were associated with increased mortality. Subgroup analysis including high risk showed similar results. In conclusion PCI in cardiac arrest patients demonstrated improved survival irrespective of the type of cardiac arrest, presence of STEMI or shock.

Keywords: Cardiac arrest; Percutaneous coronary intervention; PCI utilization

Introduction

Cardiac arrest accounts for approximately 15% of total deaths in the United States [1]. Study done by Bayes de Luna et al. [2] showed that ventricular arrhythmias are associated with 84% cases of cardiac arrest and ventricular fibrillation (Vfib) was found to be the most common underlying rhythm [2,3]. Coronary artery disease (CAD) has been implicated as a most common cause of cardiac arrest and thought to be present in 70% of patients experiencing cardiac arrest [4]. Study by Rea et al. [4] demonstrated 4-6 fold rise in the incidence of cardiac arrest in patients with clinically recognized CAD. Numerous studies have been done to establish the role of PCI in post-cardiac arrest patients but outcome is still debatable. There are studies which showed improved survival in patients receiving PCI [5-10], on the other hand, some studies showed benefits only in STEMI patients [11,12]. Bulut et al. [13] found no mortality benefit of performing PCI at all. Study done by Zanuttini et al. [14] and Spaulding et al. [15] suggested that electrocardiogram should not be a criterion to perform coronary angiography (CA)/PCI in cardiac arrest patients. There is very sparse real time national data on outcomes of cardiac arrest post PCI. In our study we focused on 1) Impact of PCI on in- hospital mortality including multiple clinically important subgroups 2) Other predictors of in -hospital mortality 3) predictors of length of stay and cost of care 4) Variation in the utilization of PCI and predictors of PCI utilization.

Methods

Nationwide inpatient sample database (NIS) from 2008-2012 was used to select the study cohort. NIS is a subset of the "Healthcare Cost and Utilization Project" (HCUP) sponsored by the agency for healthcare research and quality. The NIS is the largest publicly available all-payer inpatient care database in the United states (US), including data on approximately 7 to 8 million discharges per year, and is a stratified sample designed to approximate a 20% sample of US community (nonfederal, short-term, general, and specialty) hospitals [16,17]. National estimates are produced using sampling weights provided by the sponsor. To maintain the internal validity of the database, periodic scrutiny of NIS data quality is performed. NIS database has been found very useful particularly in explain trends in acute medical and surgical conditions [18] and also has been found to be consistent with other hospitalization discharge databases in the United States [19].

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Diagnosis and procedure of interest were identified using the International Classification of diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes. Cardiac arrest was identified using ICD-9 diagnosis codes either primary or secondary codes 427.5 (Figure 1). Percutaneous coronary interventions were identified using ICD-9 procedural codes: (36.06, 36.07). The primary outcome was the occurrence of In- hospital mortality; secondary outcomes were length of stay and cost of care. We also studied predictors of utilization of PCI in cardiac arrest patients.

NIS variables were used to identify patient's demographic characteristics including age, gender, and race (Table 1). Deyo modification of Charlson co-morbidity index (CCI) [20] was utilized to identify the severity of co-morbidities. This index uses 17 co-morbid conditions and score range from 0 to 33 with higher scores indicating greater burden of co-morbid conditions (supplementary Table 1). Teaching hospitals were distinguished from non-teaching if they had an American Medical Association approved residency program, were a member of the Council of Teaching Hospitals, or had a fulltime equivalent interns and residents to patient's ratio of 0.25. Similar method has been used in the previous studies [21]. The HCUP NIS contains data on total charges for each hospital in the databases, which represent the amount that hospitals billed for services. To calculate estimated cost of hospitalizations, the NIS data were merged with Cost to charge ratios (CCR) available from HCUP. Using the merged data elements from the CCR files and the total charges reported in the NIS database, we converted the hospital total charge data to cost estimates by simply multiplying total charges with the appropriate CCR. These costs are in essence standardized, can be measured across hospitals, and are used in the remainder of this report. Adjusted cost for each year was calculated in terms of the 2012 cost, after adjusting for inflation according to the latest consumer price index data released by US government on January 16, 2013. The similar method has been used for previous studies [22].

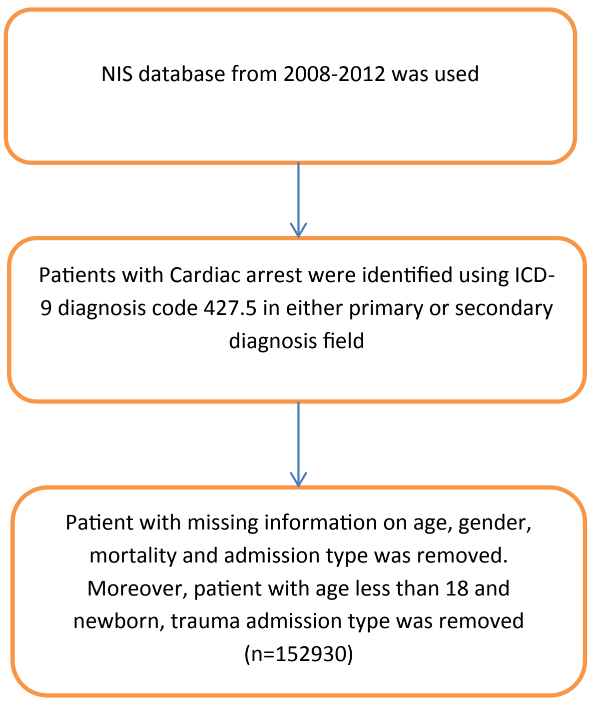

Figure 1: Data extraction algorithm.

Overall cardiac arrest patients(unweighted)	152930
Overall cardiac arrest patients (weighted)	756036
Patient level variables	
Age	4.11
18-34	10.02
35-49	27.02
50-64	33.91
65-79	24.93
>=80	
Gender	
Male	54.99
Female	45.01
Race	
White	60.63
Non-white	28.02
Missing	11.36
Comorbidities	
Charlson/deyo comorbidity index	
0	16.7
1	23.21
>=2	60.1
Obesity	11.02
History of hypertension	56.2
History of diabetes	31.92
Congestive heart failure	19.08
History of chronic pulmonary disease	24.49
Peripheral vascular disease	10.76
Renal failure	61.94
Neurological disorder or paralysis	16.25
Anemia or coagulopathy	24.75
Hematological or oncological malignancy	7.39
Weight loss	10.95
Rheumatoid arthritis or other collagen vascular	2.38
Valvular heart disease	5.31
Depression, psychosis or substance abuse	13.21
Diagnosis and procedures	
STEMI[a]	11.82
NSTEMI[b]	11.04
Shock	26.91
PCI[c]	8.07
Ventricular tachycardia[d]/Vfib[e]	24.37
Median household income category for patient's zip code[f]	
1. 0-25th percentile	30.73
2. 26-50th percentile	25.62
3. 51-75th percentile	22.78
4. 76-100th percentile	18.34
Primary Payer	
Medicare / Medicaid	71.86
Private including HMO[g]	19.85
Self-pay/no charge/other	8.08
Hospital characteristics Hospital bed size	
Small	10.36
Medium	22.91
Large	65.85
Hospital Region	
Northeast	16.27

Midwest or North Central	22.31
South	41.13
West	20.3
Hospital Teaching status	
Non-teaching	49.75
Teaching	47.42
Admission day	
Weekdays	75.43
Weekend	24.57
Outcome	
Home	18.71
Facility/others	21.27
In-hospital mortality	59.54
Length of stay	14 ± 0.07
Average cost of Care	31991 ± 113

a: STEMI=ST Elevation Myocardial Infarction; b: NSTEMI=Non ST Elevation Myocardial Infarction; c:PCI=Percutaneous Coronary Intervention; d:Vtach=Ventricular Tachycardia ; e: Vfib=Ventricular Fibrillation; f: HMO=Health Maintenance organization.
ICD9 codes – Cardiac arrest: 427.5; PCI: 36.06, 36.07, 0.66; STEMI: 410.xx

Table 1: Baseline characteristics of study population.

SAS 9.4 (SAS Institute Inc, Cary, North Carolina) were used for analyses. Weighted values of patient-level observations were generated to produce a nationally representative estimate of entire US population of hospitalized patients. Differences between categorical variables were tested using the chi-square test, and differences between continuous variables were tested using the Student t test. P-value<0.05 was considered significant. Hierarchical models or multilevel models are designed to analyze data with nested observations. The NIS data set is inherently hierarchical, viz., the data have group-specific (i.e., hospital) attributes, and within each group (i.e., hospital), there are patients, which contribute patient-specific attributes to the data. Hierarchical models take into consideration the effect of nesting (e.g., patient-level effects nested within hospital-level effects). Hence, it is superior to simple regression modeling for the available data set. Hierarchical mixed-effects logistic regression models were used for categorical-dependent variables such as primary and hierarchical mixed-effects linear regression models were used for continuous-dependent variable such as the cost of care and length of stay. Two-level hierarchical models (with patient-level factors nested within hospital-level factors) were created with the unique hospital identification number incorporated as random effects within the model. In all multivariate models, we included hospital-level variables such as hospital region (South, Midwest, West with Northeast as reference), hospital bed size (small as reference vs medium vs large), teaching versus nonteaching hospital, and patient-level variables such as age, gender, Deyo modification of CCI, admission over the weekend, primary payer (Medicare/Medicaid as referent vs Private vs self-pay), STEMI, Shock and PCI and Median household income. Per HCUP classification, median household income of patients for zip code is divided into four categories based on annual income which is variable every year [23].

Result

We identified 152,930 patients, representative of 756,036 nationwide. Baseline characteristics of the patient population involved in the study is shown in Table 1. Overall 54.99% were men, 60.63% were whites. 60.1% of the subjects had CCI ≥ 2 with renal failure (61.94%), hypertension (56.2%) and diabetes (31.92%) being the most common comorbidities. In terms of income, 30.73% belonged to category I (lowest SES) and 18.34% were from category IV (highest SES). Medicare/Medicaid was primary payer for 71.86% patients. 65.85% of patients were admitted to large hospitals, 49.75% of the totals were non-teaching facilities, and 75.43% admissions were during week days. 26.91% of patients had with shock. Vtach/Vfib were rhythms identified in 24.37% of the patients.

Multivariate analysis (Table 2) demonstrated that age (OR: 1.01, 95%CI 1.01 to 1.02, p<0.001), STEMI (OR: 1.44, 95%CI: 1.38 to 1.51, p<0.001), presence of shock (OR: 1.66, 95%CI: 1.61 to 1.70, P<0.001), higher baseline comorbidities depicted by Charlson comorbidity index(CCI) ≥ 2 (OR:1.08, 95%CI: 1.04 to1.12, p<0.001) as compare to CCI of 0, Self-pay (OR:1.48, 95%CI: 1.46 to1.56, p<0.001) as compared to Medicaid/Medicare, admission during weekends (OR: 1.17, 95%CI :1.14 to1.20, p<0.001) as compared to weekday admission, admission in hospital located in west region (OR:1.08, 95% CI: 1.01 to 1.16 , p<0.05) as compare to northeast hospitals, all were associated with increased mortality. On the other hand, patients presenting with Vtach/Vfib (OR:

	Odds ratio	LL	UL	P-value
Age	1.01	1.01	1.02	<.0001
Female sex	0.99	0.97	1.02	0.6224
PCI	0.24	0.23	0.25	<.0001
STEMI	1.44	1.38	1.51	<.0001
Shock	1.66	1.61	1.70	<.0001
Ventricular tachycardia/Vfib	0.53	0.51	0.54	<.0001
Charlson Score*				
0	**Referent**	**Referent**	**Referent**	
1	0.98	0.94	1.02	0.3211
>=2	1.08	1.04	1.12	<.0001
Primary Payer				
Medicare / Medicaid	**Referent**	**Referent**	**Referent**	
Private including HMO	0.89	0.86	0.92	<.0001
Self -pay/no charge/other	1.48	1.40	1.56	<.0001
Median household income category for patient's zip code[a]				
1. 0-25th percentile	**Referent**	**Referent**	**Referent**	
2. 26-50th percentile	0.93	0.89	0.96	<.0001
3. 51-75th percentile	0.91	0.87	0.94	<.0001
4. 76-100th percentile	0.86	0.82	0.89	<.0001
Admission time				
Weekday	**Referent**	**Referent**	**Referent**	
Weekend	1.17	1.14	1.20	<.0001
Hospital teaching status				
Non- teaching	**Referent**	**Referent**	**Referent**	
Teaching	0.94	0.90	0.99	0.016
Hospital Bed size				
Small	**Referent**	**Referent**	**Referent**	
Medium	0.99	0.93	1.06	0.8073
Large	0.96	0.90	1.02	0.1755
Hospital Region				
North east	**Referent**	**Referent**	**Referent**	
Midwest	0.95	0.88	1.03	0.1889
South	1.05	0.98	1.12	0.1447
West	1.08	1.01	1.16	0.0244
C- index[b]	0.65			

a=C-index is measure of the predictive accuracy of a logistic regression model.

Table 2: Multivariate predictors of in hospital Mortality.

0.53, 95% CI: 0.51-0.53, P<0.001), higher socioeconomic status (OR: 0.86, 95% CI, 0.82-0.89, p<0.001) as compare to lower socioeconomic status, private insurance (OR: 0.89, 95% CI: 0.86-0.92, p<0.001) as compare to Medicaid/Medicare, teaching hospitals (OR: 0.94, 95% CI: 0.90-0.99, p-0.016) as compared to non-teaching hospitals were associated with decreased mortality.

Subgroup analysis (Table 3) was performed which showed survival benefit in all subgroups of patients particularly in patients with STEMI (OR: 0.26, 95% CI 0.24 to 0.28, p<0.001), presence of Shock (OR: 0.34, 95%CI: 0.31 to 0.37, p<0.001), Vtach/Vfib cardiac arrest (OR:0.25, 95%CI 0.23 to0.27, p<0.001), Asystole/PEA cardiac arrest (OR:0.24, 95%CI 0.23 to0.26, p<0.001). Mortality benefit was also seen in patients aged more or equal than 80 yrs. (OR: 0.30, 95%CI: 0.27-0.34, P<0.001), patients with higher baseline comorbidities as indicated by CCI >=2 (OR: 0.26, 95%CI: 0.25-0.28, P<0.001). We further divided patients based on presence or absence of shock during the presentation. We found significant mortality benefit in both groups as demonstrated in Table 3.

Further Multivariate analysis done to find out the predictors of utilization of PCI (Table 4) in different subgroups and it showed that cardiac arrest patients with STEMI (OR:16.91, 95%CI:16.05 to 17.82, p<0.001), cardiac arrest patients with shock (OR:1.40, 95%CI:1.33 to1.47, p<0.001), Vtach/Vfib cardiac arrest patients (OR:3.49, 95%CI:3.32 to 3.67, p<0.001), patients with private insurance (OR:1.63, 95%CI:1.54 to 1.73, p<0.001) as compare to Medicare/Medicaid, patients with household income category IV (OR:1,23, 95%CI:1.12 to1.34, p<0.001) as compare to group I, patients admitted to teaching hospitals (OR:1.26, 95%CI: 1.15 to1.37, p<0.001), patients admitted in large hospitals (OR:1.83, 95%CI:1.53 to2.19, p<0.001) as compare to small hospitals and patients admitted in hospitals in Midwest (OR:1.38, 95% CI:1.19 to1.60, p<0.001) as compare to northeast were more likely to get PCI whereas female patients(OR: 0.77, 95%CI: 0.73 to 0.81, p<0.001), patients admitted on weekends (OR:0.94, 95% CI:0.89 to 0.99,p=0.023) were less likely to get PCI.

Subgroups	odds ratio	LL	UL	P-value
STEMI	0.26	0.24	0.28	<0.001
Shock	0.34	0.31	0.37	<0.001
Non Shock	0.19	0.18	0.20	<0.001
Vfib/Vtach	0.25	0.23	0.27	<0.001
PEA or asystole	0.24	0.23	0.26	<0.001
Age>=80	0.30	0.27	0.34	<0.001
Charlson score>=2	0.26	0.25	0.28	<0.001
Vfib/Vtach and STEMI	0.25	0.23	0.28	<0.001
Vfib/Vtach and no STEMI	0.25	0.22	0.28	<0.001
(PEA or asystole) and STEMI	0.27	0.24	0.30	<0.001
(PEA or asystole) and no STEMI	0.23	0.21	0.26	<0.001
Non Shock patients only				
STEMI	0.20	0.18	0.22	<0.001
Vfib/Vtach	0.19	0.17	0.21	<0.001
PEA or asystole	0.20	0.18	0.22	<0.001
Age>=80	0.25	0.22	0.29	<0.001
Charlson score>=2	0.22	0.20	0.24	<0.001
Vfib/vtach and STEMI	0.19	0.16	0.22	<0.001
Vfib/Vtach and no STEMI	0.21	0.18	0.24	<0.001
(PEA or asystole) and STEMI	0.21	0.18	0.24	<0.001
(PEA or asystole) and no STEMI	0.20	0.17	0.23	<0.001
Shock patients only				
STEMI	0.37	0.33	0.41	<0.001
Vfib/Vtach	0.35	0.31	0.39	<0.001
PEA or asystole	0.34	0.31	0.38	<0.001
Age>=80	0.40	0.33	0.49	<0.001
Charlson score>=2	0.34	0.31	0.38	<0.001
Vfib/Vtach and STEMI	0.37	0.32	0.43	<0.001
Vfib/Vtach and no STEMI	0.33	0.28	0.40	<0.001
(PEA or asystole) and STEMI	0.37	0.32	0.43	<0.001
(PEA or asystole) and no STEMI	0.31	0.27	0.37	<0.001
PEA=Pulseless Electrical Activity, Vtach=Ventricular Tachycardia,				

Table 3: Subgroup analysis of In Hospital Mortality.

	Odds ratio	LL	UL	P-value
Age	1.00	1.00	1.00	0.0004
Female sex	0.77	0.73	0.81	<.0001
STEMI	16.91	16.05	17.82	<.0001
Shock	1.40	1.33	1.47	<.0001
Ventricular tachycardia/Vfib	3.49	3.32	3.67	<.0001
Charlson Score				
0	Referent	Referent	Referent	
1	2.54	2.29	2.83	<.0001
>=2	1.82	1.63	2.02	<.0001
Primary Payer				
Medicare / Medicaid	Referent	Referent	Referent	
Private including HMO	1.63	1.54	1.73	<.0001
Self pay/no charge/other	1.33	1.22	1.45	<.0001
Median household income category for patient's zip code				
1. 0-25th percentile	Referent	Referent	Referent	
2. 26-50th percentile	1.08	1.01	1.17	0.0302
3. 51-75th percentile	1.20	1.11	1.29	<.0001
4. 76-100th percentile	1.23	1.12	1.34	<.0001
Admission time				
Weekday	Referent	Referent	Referent	
Weekend	0.94	0.89	0.99	0.023
Hospital teaching status				
Non- teaching	Referent	Referent	Referent	
Teaching	1.26	1.15	1.37	<.0001
Hospital Bed size				
Small	Referent	Referent	Referent	
Medium	1.51	1.25	1.83	<.0001
Large	1.83	1.53	2.19	<.0001
Hospital Region				
North-west	Referent	Referent	Referent	
Midwest	1.38	1.19	1.60	<.0001
South	1.13	0.98	1.31	0.1015
west	1.13	0.96	1.33	0.14
C- index	0.87			

Table 4: Multivariate predictors of PCI utilization.

The average length of stay was 14 ± 0.07 days and the average cost of hospitalization was $31,991 ± 113 (Table 1). As shown in Table 5, patients receiving PCI had shorter hospital stay by (-4.13 days, 95%CI -4.71 to -3.56, P<0.001) but had increased cost of care (Table 6) by $+7280 (95%CI +6174 to +8386, p<0.001). High basal co-morbidities indicated by high CCI score >=2 was associated with longer length of

	LOS	LL	UL	P-value
Age	+0.11	+0.10	+0.12	<.0001
Female sex	+0.05	-0.27	+0.36	0.773
PCI	-4.13	-4.71	-3.56	<.0001
STEMI	-2.05	-2.66	-1.45	<.0001
Shock	+7.14	+6.76	+7.52	<.0001
Ventricular tachycardia/Vfib	-1.14	-1.49	-0.80	<.0001
Charlson Score				
0	**Referent**	**Referent**	**Referent**	
1	+1.25	+0.75	+1.74	<.0001
>=2	+2.90	+2.46	+3.34	<.0001
Primary Payer				
Medicare / Medicaid	**Referent**	**Referent**	**Referent**	
Private including HMO	-2.65	-3.05	-2.25	<.0001
Self- pay/no charge/other	-2.44	-3.07	-1.81	<.0001
Median household income category for patient's zip code				
1. 0-25th percentile	**Referent**	**Referent**	**Referent**	
2. 26-50th percentile	-0.32	-0.75	+0.12	0.159
3. 51-75th percentile	-0.48	-0.95	-0.02	0.042
4. 76-100th percentile	-0.57	-1.09	-0.05	0.033
Admission day				
Weekday	**Referent**	**Referent**	**Referent**	
Weekend	+0.09	-0.27	+0.46	0.617
Hospital teaching status				
Non- teaching	**Referent**	**Referent**	**Referent**	
Teaching	+3.66	+3.08	+4.24	<.0001
Hospital Bed-size				
Small	**Referent**	**Referent**	**Referent**	
Medium	-0.14	-1.01	+0.73	0.757
Large	+1.36	+0.56	+2.16	0.002
Hospital Region				
North-west	**Referent**	**Referent**	**Referent**	
Midwest	-4.01	-5.03	-3.00	<.0001
South	-1.34	-2.29	-0.40	0.006
west	-1.27	-2.29	-0.24	0.015

Table 5: Predictors of Length of stay.

stay by (+2.90 days, 95%CI +2.46-+3.34, P<0.001) and increased cost of care by (+$5150, 95%CI +4474 to +5825, P<0.001). Private insurance holders had decreased length of stay by (-2.65 days, 95%CI -3.05 to -2.25, P<0.001) (Table 5). Similarly admission in teaching hospital was associated with lengthier stay by (+3.66 days, 95%CI +3.08 to +4.24, P<0.001) and increased cost ($+8946, 95%CI +7740 to10152, P<0.001). Hospitals located in Midwest were associated with shorter stay by (-4.01 days, 95%CI -5.03 to -3.00, P<0.01) and reduced cost by $-2745 (95%CI -4846 to -645, P=0.01) as compared to hospitals located in the northwest.

Discussion

Result of our study clearly demonstrated improved survival with PCI in cardiac arrest patients, which were also shown in previous studies [5-10,24,25]. Statistical significant mortality benefit was also shown to be present in important subgroups including patients presenting with shock, without shock, patients with shockable rhythms (Vtach/Vfib), patients with non-shockable rhythms (Asystole/PEA), older patients (≥80 years) and patients with high burden of comorbidities as indicated by CCI ≥ 2. Multivariate analysis revealed higher PCI utilization with STEMI, Vtach/Vfib, Private payer, higher SES, admission in teaching hospitals as compared to non-teaching.

We observed the decrease in hospital mortality in Midwest region as compared to northwest region and in patients with higher SES as compared to lower SES which could be partially explained by higher utilization of PCI in Midwest region and higher socioeconomic status. Favorable outcomes were found with PCI in cardiac arrest patients with non-shockable rhythms which is similar to study done by Kim et al. [26]. Subgroup analysis also showed benefits of performing PCI in patient presenting with shock. This finding is supported by study done by Mylotte et al. [27] but they studied the effect of multi-vessel PCI (not investigated in our study). Our study also supported mortality benefits in cardiac arrest patients presenting without shock. Our finding of Mortality benefit of PCI in cardiac arrest patients without STEMI contradicted previous literature [11,12]. In fact, impact of PCI was comparable in both STEMI and NSTEMI subgroups. These findings were consistent with previous literature [28,29].

	cost of care	LL	UL	P-value
Age	+329	+312	+346	<.0001
Female sex	-1552	-2031	-1073	<.0001
PCI	+7280	+6174	+8386	<.0001
STEMI	-2151	-3195	-1108	<.0001
Shock	+10713	+10165	+11261	<.0001
Ventricular tachycardia/Vfib	+5306	+4730	+5881	<.0001
Charlson Score				
0	**Referent**	**Referent**	**Referent**	
1	+2645	+1876	+3413	<.0001
>=2	+5150	+4474	+5825	<.0001
Primary Payer				
Medicare / Medicaid	**Referent**	**Referent**	**Referent**	
Private including HMO	-602	-1250	+47	0.069
Self- pay/no charge/other	-7334	-8273	-6395	<.0001
Median household income category for patient's zip code				
1. 0-25th percentile	**Referent**	**Referent**	**Referent**	
2. 26-50th percentile	+719	+42	+1396	0.038
3. 51-75th percentile	+1202	+477	+1926	0.001
4. 76-100th percentile	+1861	+1021	+2702	<.0001
Admission day				
Weekday	**Referent**	**Referent**	**Referent**	
Weekend	-2430	-2977	-1884	<.0001
Hospital teaching status				
Non- teaching	**Referent**	**Referent**	**Referent**	
Teaching	+8946	+7740	+10152	<.0001
Hospital Bed size				
Small	**Referent**	**Referent**	**Referent**	
Medium	-449	-2074	+1177	0.591
Large	+2833	+1325	+4342	0.001
Hospital Region				
North-west	**Referent**	**Referent**	**Referent**	
Midwest	-2745	-4846	-645	0.011
South	-1925	-3874	+24	0.053
west	+6964	+4802	+9126	<.0001

Table 6: Predictors of cost of hospitalization.

Another important aspect of the study was PCI utilization trend. Minimal data regarding PCI utilization in the cardiac arrest is available. STEMI is found to be a strong predictor of PCI utilization in this study which was also supported by previous studies [30] and current guidelines [31]. Our study also revealed gender disparity in PCI utilization, with females less likely to receive PCI for cardiac arrest. These results were similar to previous studies [32,33] demonstrating similar disparity in PCI utilization, although these studies focused primarily on PCI utilization trend in acute coronary syndrome (ACS) patients. Further disparities in PCI utilization were revealed with private insurance holders were more likely to receive PCI as compared to government sponsored insurance holders (Medicare/Medicaid). Similar results have been demonstrated by Canto et al. [34] in ACS patients. Our study also supported the "weekend effect" leading to less PCI on patients admitted during weekend as compared to weekdays and as predicted mortality is higher in these patients. Similar results have been obtained in previous studies [35].

We also focused on the impact of PCI on the length of stay (LOS) and the total cost of care (COC). Limited data regarding impact of PCI on LOS in cardiac arrest patient is available. This study showed that PCI greatly reduced LOS in cardiac arrest patients but increased cost of care. Decreased LOS is an indirect indicator of better outcome following PCI in cardiac arrest patients. We demonstrated an inverse correlation between PCI utilization and LOS in hospital following cardiac arrest. For example STEMI patients, private insurance holders, higher SES, hospital located in midwest region were associated with increased PCI utilization and shorter LOS.

Limitations

Our study has several limitations as well and most important among them is observational design of our study and absence of randomization which precludes any casual association. Additionally we couldn't include several potential confounders in our analysis. For example, the influence of medication or implantable cardioverter-defibrillator implantation and withdrawal of life-sustaining measures which can influence the result couldn't be adjusted for. Other limitation of our study was that our follow-up was limited to hospital stay. Lastly this study focused on mortality benefit during hospital stay and we neither assessed functional status nor quality of life after discharge.

Conclusion

In conclusion, emergent PCI after cardiac arrest was associated with significant mortality benefit in all cardiac arrest patients regardless of type of initial rhythm (Vtach/Vfib vs Asystole/PEA), presence or absence of shock during presentation or ST segment changes. Further large randomized trials are needed to find out if these results are universally applicable.

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