Technical Note

For

The California Elective Percutaneous Coronary Intervention Program Report, 2018

July 2020

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APPENDICES

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Introduction

This technical note describes the research methods used to develop the third report of the California Elective Percutaneous Coronary Intervention (PCI) Program at the Office of Statewide Health Planning and Development (OSHPD): *The California Elective Percutaneous Coronary Intervention (PCI) Program Report,* 2018. This report is produced by OSHPD in compliance with California Health and Safety Code Section 1256.01 and can be found at: OSHPD PCI Reports. See Appendix A for definitions of some of the technical terms used in this document.

Hospital Performance Measures Reported

This report provides hospital performance data on three key measures of PCI:
- Mortality
- Post-PCI stroke
- Post-PCI emergency coronary artery bypass (ECAB) graft surgery

Two of the three outcome measures, mortality and post-PCI stroke, are risk-adjusted to account for variation in the health status of patients prior to PCI. Risk-adjusted rates for post-PCI ECAB graft surgery were not calculated as data needed to derive the statewide rate for comparison were not available in the National Cardiovascular Data Registry (NCDR) CathPCI Registry (see Post-PCI ECAB section below for more details).

Measure Definitions:

> *Mortality* is defined as a patient death that occurred at the facility where the PCI was performed regardless of length of stay or patient status (i.e., inpatient or outpatient).
> *Post-PCI stroke* is defined as an ischemic or hemorrhagic stroke that occurred after PCI and did not resolve within 24 hours.
> *Post-PCI ECAB* is defined as an emergency or salvage coronary artery bypass graft (CABG) surgery that occurred in hospital (including transfers to other hospitals) after the PCI.

PCI Volume, Study Population, and Data Source

PCI Volume & Study Population

Beginning in the 2nd quarter (Q2) of 2018, NCDR upgraded the CathPCI Registry from version 4.4 to version 5.0. This was a significant upgrade from v. 4.4 which was implemented in 2009. In v. 5.0, many new data elements were added, some previous data elements were discontinued, and a number were changed. Some of the changes to v. 5.0 were such that many of the data elements, including those used as risk factors in prior reports for this program, were no longer compatible across 2018 Q1 (v. 4.4) and 2018 Q2-Q4 (v. 5.0). Data could therefore not be modeled across the full year of 2018. Accordingly, only data from 2018 Q2-Q4 will be included in the current report such that all descriptive statistics, models, and rates and other measures will reflect only data obtained in these quarters rather than for the full year. In addition, all subsequent references to the year 2018 will only refer to this time range. However, full year case numbers and observed outcome counts will be provided for all and elective PCIs for certified hospitals (see Appendix B). Full year modeling and reporting will resume and include v. 5.0 data for 2019 and each subsequent

reporting year until or unless a similar CathPCI Registry version change occurs outside of Q1 for any reporting year.

For 2018, the NCDR CathPCI Registry includes a total of 39,866 PCIs performed at 131 general acute care hospitals in California (Table A). Of these, 14,663 (36.78%) were elective PCIs, 25,192 (63.19%) were non-elective or primary PCIs, and 11 (0.03%) had missing PCI status. The hospitals include 13 certified hospitals *without* on-site cardiac surgery, certified by the California Department of Public Health (CDPH) in California's Elective PCI Program and 118 non-program hospitals. The study population for this report consists of all adult patients who underwent PCI and were discharged in 2018. Note that two certified hospitals had data that was not received or accepted by NCDR for certain quarters in 2018: Clovis Community Medical Center (Q3) and Kaiser Foundation Hospital – Walnut Creek (Q3-Q4).

Table A. California PCI Volume, 2018

PCI Status	Certified Hospitals (N = 13)		Non-Program Hospitals (N = 118)		All Hospitals (N = 131)	
	Cases	%	Cases	%	Cases	%
Elective PCIs	748	24.86%	13,915	37.75%	14,663	36.78%
Non-Elective PCIs	2,261	75.14%	22,931	62.22%	25,192	63.19%
Missing	0	0.00%	11	0.03%	11	0.03%
All PCIs	3,009	100%	36,857	100%	39,866	100%

Data Source

The data source for this report is the 2018 NCDR CathPCI Registry (v. 5.0) data collected by NCDR from the 131 hospitals described above. The NCDR CathPCI Registry data were obtained by OSHPD in compliance with California Health and Safety Code § 1256.01 and OSHPD's contract with the American College of Cardiology Foundation.

Risk Model for Adjusting Hospital PCI Mortality Rates

This section explains the development and validation of the risk model that accounts for the variation in patient severity of illness for mortality. A multivariable logistic regression model estimates the relationship between each of the demographic and pre-operative risk factors and the probability of mortality.

To develop the risk model for hospital mortality rates, 39,866 total PCI cases were evaluated for missing data; 38,462 cases had no missing data in any field and were used for the risk model parameter estimation. The 1,404 (4%) PCI cases with missing data fields were removed from the data used for model development to ensure that the effects of the risk factors were estimated based on the most complete data available.

After risk model development, the complete file was used to generate the hospital specific results. Missing values were imputed by replacing them with the lowest risk category of the same variable (e.g., *Chronic Lung Disease = none*). The lowest risk value is assigned for the following reasons: 1) Some hospitals leave data fields blank by design when the risk factor is absent or the value is normal and 2) it maintains consistency with other major cardiac reporting programs that replace

missing data with the lowest-risk or normal value. After imputing the missing values, the parameters of the risk model were applied to all cases to estimate each patient's probability of death. These probabilities were summed to estimate the expected mortality for each hospital. The risk model, based on the 2018 data, is presented in Table B-1 with statistically significant risk factors identified in bolded text. Note that there are Not Applicable (N/A) levels for the variables: Left Ventricular Ejection Fraction, Cardiovascular Instability Type, and Pre-PCI Mechanical Support. These levels are due to negative responses to the parent variable (i.e., they are N/A to the response of the child variable), and they are not included in the table because the comparisons would not be meaningful. In addition, these levels could be significant and may result in the overall significance of a variable (e.g., Pre PCI Mechanical Support).

Table B-1: Logistic Regression Risk Model for PCI Mortality

Risk Factor		Coefficient	Standardrror	P-value	Odds Ratio
Intercept		-3.2762	0.4617	<.0001	
Age (Years)		**0.0309**	**0.0038**	**<.0001**	**1.031**
Glomerular Filtration Rate MDRD		**-0.0142**	**0.0016**	**<.0001**	**0.986**
Hemoglobin		**-0.1442**	**0.0203**	**<.0001**	**0.866**
Left Ventricular Ejection Fraction	>=40%	Reference			
	30-39%	**0.7051**	**0.2017**	**0.0005**	**2.024**
	20-29%	0.4190	0.2414	0.0827	1.520
	<20%	**1.5431**	**0.3083**	**<.0001**	**4.679**
PCI Status	Elective	Reference			
	Urgent	**0.9242**	**0.1770**	**<.0001**	**2.520**
	Emergent	**1.8198**	**0.1918**	**<.0001**	**6.171**
	Salvage	**3.3954**	**0.2606**	**<.0001**	**29.826**
Pre-Procedure TIMI	TIMI - Other	Reference			
	TIMI - 0	**0.2212**	**0.0940**	**0.0187**	**1.248**
Heart Failure		**0.2458**	**0.0921**	**0.0076**	**1.279**
Tobacco Use	Never Smoked	Reference			
	Current Every Day	0.0475	0.1293	0.7132	1.049
	Current Some Day	0.1088	0.3971	0.7841	1.115
	Former Smoker	0.0306	0.0954	0.7485	1.031
	Smoker, Current Status Unknown	-0.2065	0.4028	0.6082	0.813
	Unknown if Ever Smoked	**1.0578**	**0.2329**	**<.0001**	**2.880**
Dyslipidemia		**-0.2722**	**0.0914**	**0.0029**	**0.762**
Cardiovascular Instability (CI) Type	Other CI Type	Reference			
	Cardiogenic Shock	**0.9213**	**0.1142**	**<.0001**	**2.512**
	Refractory Shock	**1.8964**	**0.3179**	**<.0001**	**6.662**
Cerebrovascular Disease		**0.3594**	**0.1114**	**0.0013**	**1.432**
Peripheral Arterial Disease		**0.4651**	**0.1159**	**<.0001**	**1.592**
Pre PCI Mechanical Support	No	Reference			
	Yes	0.0038	0.1268	0.9762	1.004
MDRD: Modification of Diet in Renal Disease. TIMI: Thrombolysis in Myocardial Infarction. **Bolded text** indicates statistical significance.					

Discrimination of Risk Model for PCI Mortality

A commonly used measure of discrimination is the C-statistic, also known as the area under the curve of the receiver operating characteristic curve. For all possible pairs of patients, where one dies and the other survives PCI, the C-statistic describes the proportion of pairs where the patient who died had a higher predicted risk of death than the patient who lived.

C-statistics range from 0.5 to 1, with higher values indicating better discrimination. For the 2018 mortality risk model, the C-statistic was 0.932. In the most recently published PCI outcomes report for State of New York (2014-2016), the mortality risk model C-statistic for all PCIs was 0.876 for 2016 (All Cases). Note that mortality in the New York report was defined as in-hospital/30-day mortality.

Calibration of Risk Model for PCI Mortality

A common measure of calibration is the Hosmer-Lemeshow χ^2 test, which compares observed and predicted outcomes over deciles of risk. The p-value of the Hosmer-Lemeshow test statistic for the mortality risk model is 0.129, indicating no significant differences between observed and predicted outcomes over deciles of risk.

A second calibration test sorts the data into 10 risk groups and compares observed deaths with predicted deaths in each of 10 risk groups. As presented in Table B-2, Risk Group 10 shows the patients in the highest risk group. Among the 3,849 patients in Group 10, 698 died and the model predicted 662.29 deaths. Assuming a Poisson distribution for a binary outcome, the predicted range of deaths for Risk Group 10 is 513.36 to 837.71. The observed number of 689 deaths falls within the range of the predicted deaths. A few of the groups showed observed deaths below the 95% lower confidence interval (CI) of the predicted deaths (e.g., groups 1, 3, and 5). However, the differences were small in the cases of fewer observed deaths (e.g., the largest difference between observed deaths and the lowest 95% CI was 2.55 (decile 5)) and the model still accounts for 99% of all mortality cases. Overall, the risk model shows no systematic underestimation or overestimation of mortality cases at the extremes.

Table B-2: Calibration of Risk Model for PCI Mortality

Risk Group	PCI Cases	Observed Deaths	Predicted Deaths	Difference	95%CI of Predicted Deaths	
1	3,845	1	2.30	1.30	1.50	3.55
2	3,846	5	4.22	-0.78	2.83	6.34
3	3,846	3	6.22	3.22	4.21	9.25
4	3,846	8	8.79	0.79	6.03	12.89
5	3,846	6	12.37	6.37	8.55	18.04
6	3,846	13	17.79	4.79	12.35	25.83
7	3,846	22	26.93	4.93	18.88	38.69
8	3,846	41	43.31	2.31	30.64	61.71
9	3,846	69	81.79	12.79	58.33	115.38
10	3,849	698	662.29	-35.71	513.36	837.71

Note: Risk Group 1 is at lowest risk for mortality and Risk Group 10 is at highest risk.

Process for Calculating Hospital Risk-Adjusted PCI Mortality Rates

The risk-adjusted mortality rate (RAMR) is computed by dividing the provider's observed mortality by the provider's expected mortality (based on the risk model) to get the observed/expected (O/E) ratio. The O/E ratio is then multiplied by the statewide observed mortality rate (2.33%) to obtain the provider's risk-adjusted mortality rate.

Although RAMRs will be reported for all and elective PCIs, note that 95% CIs and outliers will only be reported for elective PCIs. Because a provider's point estimate of the RAMR can be attributed to chance, an identified outlier will not be based on a point estimate of the RAMR, but a comparison of the 95% CIs of that provider's RAMR to the statewide observed mortality rate.[1] A positive outlier provider's RAMR is significantly better than the statewide rate if the upper 95% CI is below the statewide observed mortality rate. A negative outlier provider's RAMR is significantly worse than the statewide rate if the lower 95% CI is above the statewide observed mortality rate. If the statewide observed mortality rate is within the 95% CI of a provider's RAMR, that provider is not identified as an outlier.

Hospital PCI Mortality Results

All PCIs

The mortality results in this section and for "Elective PCIs" (below) are all derived from the same model described above in the section "Risk Model for Adjusting Hospital PCI Mortality Rates".

Table B-3 presents the risk-adjusted mortality results for each certified hospital for 2018 for all PCIs. The table contains, for each hospital, the total number of PCIs performed (elective and non-elective), number of observed mortality cases, observed mortality rate, expected mortality rate, and RAMR.

Among the 39,866 total PCIs (elective and non-elective) performed at 131 certified and non-program hospitals in 2018, 929 patients died, reflecting a statewide mortality rate of 2.33%. Among the 3,009 total PCIs performed at the 13 certified hospitals in 2018, 63 patients died, reflecting a certified hospital mortality rate of 2.09%. The *observed* mortality rate among certified hospitals ranged from 0.00% to 7.14%. The *expected* mortality rates for certified hospitals, which are generated by the risk model and account for patient severity-of-illness, were between 0.64% and 7.02%. The RAMR for certified hospitals ranged from 0.00% to 3.47%.

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[1] The Elective PCI Program at OSHPD uses the Poisson Exact Probability method to compute the 95% CI for the risk-adjusted mortality rate. (Buchan Iain, *Calculating Poisson Confidence Interval in Excel*, January 2004).

Table B-3: Certified Hospital Risk-Adjusted PCI Mortality Results for All PCIs

Certified Hospital	All PCI Cases	All PCI Mortality	Observed Mortality Rate (%)	Expected Mortality Rate (%)	Risk-Adjusted Mortality Rate (%, RAMR)
Statewide	39,866	929	2.33		
Clovis Community Medical Center	208	3	1.44	1.59	2.11
Emanuel Medical Center (Turlock)	243	3	1.23	2.23	1.29
Highland Hospital (Oakland)	132	4	3.03	4.76	1.48
Kaiser Foundation Hospital - Orange County - Irvine	320	0	0.00	0.64	0.00
Kaiser Foundation Hospital - Roseville	425	5	1.18	1.63	1.68
Kaiser Foundation Hospital - San Jose	112	8	7.14	4.80	3.47
Kaiser Foundation Hospital - South Sacramento	364	7	1.92	3.94	1.14
Kaiser Foundation Hospital - Walnut Creek	105	1	0.95	1.35	1.64
Kaiser Foundation Hospital & Rehab Center - Vallejo	260	2	0.77	1.24	1.44
Los Alamitos Medical Center	168	9	5.36	4.63	2.70
St. Rose Hospital (Hayward)	157	8	5.10	7.02	1.69
Sutter Delta Medical Center (Antioch)	205	6	2.93	2.83	2.41
Sutter Roseville Medical Center	310	7	2.26	3.44	1.53

Elective PCIs

Table B-4 presents the risk-adjusted mortality results for each certified hospital for 2018 for elective PCIs. The table contains, for each hospital, the number of elective PCIs performed, number of observed mortality cases, observed mortality rate, expected mortality rate, RAMR, and 95% CI of the RAMR.

Among the 14,674[2] elective PCIs performed at 126 certified and non-program hospitals in 2018, 44 patients died, reflecting a statewide mortality rate of 0.30%. Among the 748 elective PCIs performed at 13 certified hospitals in 2018, one patient died, reflecting a certified hospital mortality rate of 0.13%. The observed mortality rate among certified hospitals ranged from 0.00%

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[2] Note that this total includes 11 cases where PCI Status was missing (see Table A) that were subsequently imputed at the lowest risk level for that variable (i.e., elective) according to the process described above in the section "Risk Model for Adjusting Hospital PCI Mortality Rates".

to 1.85%. The expected mortality rates for certified hospitals were between 0.13% and 0.46%. The RAMR for certified hospitals ranged from 0.00% to 1.20%.

Based on the 95% CIs for RAMR, 13 of the 13 certified hospitals (100%) that performed elective PCIs were within the expected range when compared to the statewide mortality rate.

Table B-4: Certified Hospital Risk-Adjusted PCI Mortality Results for Elective PCIs

Certified Hospital	Elective PCI Cases	Elective PCI Mortality	Observed Mortality Rate (%)	Expected Mortality Rate (%)	Risk-Adjusted Mortality Rate (%, RAMR)	95%CI for RAMR
Statewide	14,674	44	0.30			
Clovis Community Medical Center	121	0	0.00	0.21	0.00	(0.00, 4.28)
Emanuel Medical Center (Turlock)	33	0	0.00	0.19	0.00	(0.00, 18.07)
Highland Hospital (Oakland)	9	0	0.00	0.16	0.00	(0.00, 77.97)
Kaiser Foundation Hospital - Orange County - Irvine	127	0	0.00	0.15	0.00	(0.00, 5.64)
Kaiser Foundation Hospital - Roseville	93	0	0.00	0.20	0.00	(0.00, 5.82)
Kaiser Foundation Hospital - San Jose	14	0	0.00	0.13	0.00	(0.00, 58.85)
Kaiser Foundation Hospital - South Sacramento	64	0	0.00	0.31	0.00	(0.00, 5.49)
Kaiser Foundation Hospital - Walnut Creek	38	0	0.00	0.17	0.00	(0.00, 16.66)
Kaiser Foundation Hospital & Rehab Center - Vallejo	73	0	0.00	0.20	0.00	(0.00, 7.73)
Los Alamitos Medical Center	54	1	1.85	0.46	1.20	(0.03, 6.67)
St. Rose Hospital (Hayward)	20	0	0.00	0.24	0.00	(0.00, 23.14)
Sutter Delta Medical Center (Antioch)	30	0	0.00	0.33	0.00	(0.00, 11.07)
Sutter Roseville Medical Center	72	0	0.00	0.19	0.00	(0.00, 8.07)

Risk Model for Adjusting Hospital Post-PCI Stroke Rates

Post-PCI stroke is a rare but serious complication that can occur after PCI. Similar to the methodology used to assess the mortality rate, a multivariable logistic regression model estimates the relationship between each of the demographic and pre-procedure risk factors and the probability of post-PCI stroke. To develop the risk model for hospital stroke rates, 39,866 all PCI cases were evaluated for missing data; 38,869 cases had no missing data in any field and were used for the risk model parameter estimation. The 997 (3%) PCI cases with missing data fields were

removed from the data used for model development to ensure that the effects of the risk factors were estimated based on the most complete data available.

To generate the hospital specific results shown in this report, missing values for these 997 records were imputed using the same method employed for the mortality risk model. The risk model, based on the 2018 data, is presented in Table C-1 with statistically significant risk factors identified in bolded text. Note that there is a Not Applicable (N/A) level for the variable Pre PCI Mechanical Support. These levels are due to negative responses to the parent variable (i.e., they are N/A to the response of the child variable), and they are not included in the table because the comparisons would not be meaningful. In addition, these levels could be significant and may result in the overall significance of a variable (e.g., Pre PCI Mechanical Support).

Table C-1: Logistic Regression Risk Model for Post-PCI Stroke

Risk Factor		Coefficient	Standard Error	P-value	Odds Ratio
Intercept		-4.8609	0.6374	<.0001	
Age (Years)	<=70	Reference			
	>70	**0.4240**	**0.1769**	**0.0166**	**1.528**
Hemoglobin		**-0.1160**	**0.0399**	**0.0036**	**0.890**
Cerebrovascular Disease		**1.1753**	**0.1881**	**<.0001**	**3.239**
PCI Status	Elective	Reference			
	Urgent	**0.9697**	**0.2881**	**0.0008**	**2.637**
	Emergent	**1.3950**	**0.3318**	**<.0001**	**4.035**
	Salvage	**1.8792**	**0.5376**	**0.0005**	**6.548**
Cardiovascular Instability		**0.5759**	**0.2195**	**0.0087**	**1.779**
Pre PCI Mechanical Support	No	Reference			
	Yes	0.4472	0.3129	0.153	1.564
STEMI: ST Elevation Myocardial Infarction. **Bolded text** indicates statistical significance.					

Discrimination of Risk Model for Post-PCI Stroke

For the 2018 stroke risk model, the C-statistic was 0.804.

Calibration of Risk Model for Post-PCI Stroke

Calibration methods are explained in the section for PCI mortality. The p-value of the Hosmer-Lemeshow test statistic for the stroke risk model is 0.424, indicating adequate calibration.

A second calibration test sorts the data and compares observed stroke cases with predicted stroke cases in each of 10 risk groups. As presented in Table C-2, Risk Group 1 shows the patients in the lowest risk group. Among the 3,952 patients in this group, zero patients had post-PCI strokes, but the model predicted 1.99 cases. Assuming a Poisson distribution for a binary outcome, the predicted range of strokes for this group is 1.14 to 3.47. The observed number of zero strokes falls below the range of predicted strokes. Two additional groups showed strokes below the 95% lower confidence interval (CI) of the predicted strokes (e.g., groups 3 and 8) and there were some under-

predicted strokes at the highest deciles. However, the differences were small in the cases of fewer observed strokes (e.g., the largest difference between observed strokes and the lowest 95% CI was 2.02 (decile 8)) and the model still accounts for 94% of all stroke cases. In addition, none of the under-predicted strokes at the higher deciles were significantly different than those predicted by the model. Overall, the risk model shows no systematic underestimation or overestimation of stroke cases at the extremes.

Table C-2: Calibration of Risk Model for Post-PCI Stroke

Risk Group	PCI Cases	Observed Strokes	Predicted Strokes	Difference	95%CI of Predicted Strokes	
1	3,952	0	1.99	1.99	1.14	3.47
2	3,822	4	2.69	-1.31	1.54	4.71
3	3,940	1	3.92	2.92	2.29	6.72
4	3,974	4	5.37	1.37	3.48	8.34
5	3,753	7	6.47	-0.53	4.20	10.05
6	3,881	10	8.69	-1.31	5.54	13.70
7	3,932	14	11.16	-2.84	7.19	17.43
8	3,841	7	13.95	6.95	9.02	21.69
9	3,889	25	21.26	-3.74	13.36	34.02
10	3,885	69	65.52	-3.48	37.85	113.96

Note: Risk Group 1 is at lowest risk for mortality and Risk Group 10 is at highest risk.

Process for Calculating Hospital Risk-Adjusted Post-PCI Stroke Rates

The risk-adjusted stroke rate (RASR) is computed by dividing the provider's number of patient strokes by the provider's expected number of patient strokes (based on the risk model) to obtain the O/E ratio. The O/E ratio is then multiplied by the statewide stroke rate (0.36%) to obtain the provider's RASR.

Similar to the RAMR, an outlier is based on a comparison of the 95% CI of that provider's RASR to the statewide stroke rate. A provider's RASR is significantly better than the statewide rate if the upper 95% CI is below the statewide observed stroke rate and a provider's RASR is significantly worse than the statewide rate if the lower 95% CI is above the statewide observed stroke rate. If the statewide observed stroke rate is within the 95% CI of a provider's RASR, that provider is not identified as an outlier.

Hospital Post-PCI Stroke Results

All PCIs

The post-PCI stroke results in this section and for "Elective PCIs" (below) are all derived from the same model described above in the section "Risk Model for Adjusting Hospital Post-PCI Stroke Rates". That is, elective PCIs are basically a subset of all PCIs that were used in the risk model for post-PCI stroke.

Table C-3 presents the risk-adjusted post-PCI stroke results for each certified hospital for 2018 for all PCIs. The table contains, for each hospital, the total number of PCIs performed (elective and non-elective), number of observed post-PCI stroke cases, observed post-PCI stroke rate, expected post-PCI stroke rate, and RASR.

Among the 39,866 total PCIs performed at 131 certified and non-program hospitals in 2018, 144 patients had a post-PCI stroke, reflecting an overall statewide rate of 0.36%. Among the 3,009 total PCIs performed at the 13 certified hospitals in 2018, 10 had a post-PCI stroke reflecting a certified hospital stroke rate of 0.33%. The observed stroke rate among certified hospitals ranged from 0.00% to 1.54%. The expected stroke rates, which were generated by the model and measure patient severity-of-illness, were between 0.22% and 0.68%. The RASR for certified hospitals ranged from 0.00% to 2.00%.

Table C-3: Certified Hospital Risk-Adjusted Post-PCI Stroke Results for All PCIs

Certified Hospital	All PCI Cases	All PCI Post-PCI Strokes	Observed Stroke Rate (%)	Expected Stroke Rate (%)	Risk-Adjusted Stroke Rate (%, RASR)
Statewide	**39,866**	**144**	**0.36**		
Clovis Community Medical Center	208	0	0.00	0.26	0.00
Emanuel Medical Center (Turlock)	243	0	0.00	0.36	0.00
Highland Hospital (Oakland)	132	1	0.76	0.59	0.46
Kaiser Foundation Hospital - Orange County - Irvine	320	0	0.00	0.22	0.00
Kaiser Foundation Hospital - Roseville	425	0	0.00	0.35	0.00
Kaiser Foundation Hospital - San Jose	112	0	0.00	0.64	0.00
Kaiser Foundation Hospital - South Sacramento	364	2	0.55	0.47	0.42
Kaiser Foundation Hospital - Walnut Creek	105	0	0.00	0.29	0.00
Kaiser Foundation Hospital & Rehab Center - Vallejo	260	4	1.54	0.28	2.00
Los Alamitos Medical Center	168	0	0.00	0.50	0.00
St. Rose Hospital (Hayward)	157	2	1.27	0.68	0.67
Sutter Delta Medical Center (Antioch)	205	0	0.00	0.38	0.00
Sutter Roseville Medical Center	310	1	0.32	0.43	0.27

Elective PCIs

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Table C-4 presents the risk-adjusted post-PCI stroke results for each certified hospital for 2018 for elective PCIs. The table contains, for each hospital, the number of elective PCIs performed, number of observed post-PCI stroke cases, observed post-PCI stroke rate, expected post-PCI stroke rate, RASR, and 95% CI of the RASR.

Among the 14,674[3] elective PCIs performed at 126 certified and non-program hospitals in 2018, 16 patients had a post-PCI stroke, reflecting an overall statewide rate of 0.11%. Among the 748 elective PCIs performed at the 13 certified hospitals in 2018, 0 had a post-PCI stroke reflecting a certified hospital stroke rate of 0.00%. The observed stroke rate among certified hospitals ranged from 0.00% to 0.00%. The expected stroke rates were between 0.08% and 0.13%.

Based on the 95% CIs for RASR, 13 of the 13 certified hospitals (100%) that performed elective PCIs were within the expected range when compared to the statewide stroke rate.

Table C-4: Certified Hospital Risk-Adjusted Post-PCI Stroke Results for Elective PCIs

Certified Hospital	Elective PCI Cases	Elective PCI Post-PCI Strokes	Observed Stroke Rate (%)	Expected Stroke Rate (%)	Risk-Adjusted Stroke Rate (%, RASR)	95%CI for RASR
Statewide	**14,674**	**16**	**0.11**			
Clovis Community Medical Center	121	0	0.00	0.11	0.00	(0.00, 3.07)
Emanuel Medical Center (Turlock)	33	0	0.00	0.09	0.00	(0.00, 13.23)
Highland Hospital (Oakland)	9	0	0.00	0.08	0.00	(0.00, 57.83)
Kaiser Foundation Hospital - Orange County - Irvine	127	0	0.00	0.09	0.00	(0.00, 3.72)
Kaiser Foundation Hospital - Roseville	93	0	0.00	0.11	0.00	(0.00, 4.14)
Kaiser Foundation Hospital - San Jose	14	0	0.00	0.08	0.00	(0.00, 35.45)
Kaiser Foundation Hospital - South Sacramento	64	0	0.00	0.09	0.00	(0.00, 6.83)
Kaiser Foundation Hospital - Walnut Creek	38	0	0.00	0.08	0.00	(0.00, 13.95)
Kaiser Foundation Hospital & Rehab Center – Vallejo	73	0	0.00	0.09	0.00	(0.00, 6.20)
Los Alamitos Medical Center	54	0	0.00	0.13	0.00	(0.00, 5.79)
St. Rose Hospital (Hayward)	20	0	0.00	0.10	0.00	(0.00, 19.61)
Sutter Delta Medical Center (Antioch)	30	0	0.00	0.11	0.00	(0.00, 12.00)

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[3] Note that this total includes 11 cases where PCI Status was missing (see Table A) that were subsequently imputed at the lowest risk level for that variable (i.e., elective) according to the process described above in the section "Risk Model for Adjusting Hospital PCI Mortality Rates".

Certified Hospital	Elective PCI Cases	Elective PCI Post-PCI Strokes	Observed Stroke Rate (%)	Expected Stroke Rate (%)	Risk-Adjusted Stroke Rate (%, RASR)	95%CI for RASR
Statewide	**14,674**	**16**	**0.11**			
Sutter Roseville Medical Center	72	0	0.00	0.09	0.00	(0.00, 6.11)

Hospital Post-PCI ECAB Results

ECAB is an uncommon but major complication that can occur after PCI. In 2018, the implementation by NCDR of the CathPCI Registry v. 5.0, resulted in analytical data that no longer includes the status of patients transferred for post-PCI ECAB. The CathPCI Registry v. 4.4 included data elements that identify patients transferred for ECAB. The CathPCI Registry v. 5.0 captures status for on-site CABGs, but for patients discharged to other acute care hospitals, the status of the CABG is not included. Accordingly, OSHPD can no longer report risk-adjusted rates on this outcome.

OSHPD, however, investigated potential transfers for ECAB from other sources. These potential transfers were then sent to certified hospitals for confirmation and those that were confirmed as transfers, are included in the current report as observed ECABs for both all and elective PCIs (see Table D-1). Note that observed ECABs could not be obtained for Non-Program hospitals as these hospitals are de-identified by NCDR in the OSHPD dataset.

Among the 3,009 total PCIs performed at the 13 certified hospitals in 2018, 6 had a post-PCI ECAB reflecting a certified hospital ECAB rate of 0.20%. Among the 748 elective PCIs performed at the 13 certified hospitals in 2018, 0 had a post-PCI ECAB reflecting a certified hospital stroke rate of 0.00%.

Table D-1: Certified Hospital Post-PCI ECAB Results for All & Elective PCIs

Certified Hospital	All PCI Cases	All PCI Post-PCI ECABs	Elective PCI Cases	Elective PCI Post-PCI ECABs
Clovis Community Medical Center	208	1	121	0
Emanuel Medical Center (Turlock)	243	1	33	0
Highland Hospital (Oakland)	132	0	9	0
Kaiser Foundation Hospital - Orange County - Irvine	320	0	127	0
Kaiser Foundation Hospital - Roseville	425	3	93	0
Kaiser Foundation Hospital - San Jose	112	0	14	0
Kaiser Foundation Hospital - South Sacramento	364	0	64	0

Certified Hospital	All PCI Cases	All PCI Post-PCI ECABs	Elective PCI Cases	Elective PCI Post-PCI ECABs
Kaiser Foundation Hospital - Walnut Creek	105	1	38	0
Kaiser Foundation Hospital & Rehab Center - Vallejo	260	0	73	0
Los Alamitos Medical Center	168	0	54	0
St. Rose Hospital (Hayward)	157	0	20	0
Sutter Delta Medical Center (Antioch)	205	0	30	0
Sutter Roseville Medical Center	310	0	72	0

Appendix A: Definition of Terms[4]

All PCI Cases: The total number of elective and non-elective PCI cases submitted to NCDR by certified hospitals and non-program hospitals. Note that non-program hospitals include those participating non-program hospitals who voluntarily submit their PCI data to NCDR. Thus, the NCDR dataset may not include all California hospitals that perform PCI.

Elective PCI Cases: The total number of elective PCI cases submitted to NCDR by certified hospitals and non-program hospitals. Elective PCIs can be performed on an outpatient basis or on an inpatient basis without significant risk of infarction or death. For stable inpatients, the PCI is performed during hospitalization for convenience and not because the patient's clinical situation demands it prior to discharge.

Non-Elective PCI Cases: The total number of non-elective PCI cases submitted to NCDR by certified hospitals and non-program hospitals. Non-elective PCI cases, also known as primary PCIs, include urgent, emergency, and salvage PCIs. Urgent PCIs are performed on an inpatient basis because of significant concerns that there is a risk of ischemia, infarction, and/or death. Emergency PCIs are performed as soon as possible because of substantial concerns that ongoing ischemia and/or infarction could lead to death. Salvage PCIs are performed when a patient is in cardiogenic shock when the PCI begins. In addition, the patient has also received chest compressions for at least 60 seconds or has been on extracorporeal mechanical oxygenation or cardiopulmonary support (within ten minutes prior to the procedure or during the diagnostic portion).

Certified Hospitals: General acute care California hospitals certified by CDPH in California's Elective PCI Program. These hospitals may perform PCIs *without* cardiac surgery on-site and report all PCI cases to NCDR. These hospitals must perform a minimum of 100 PCIs (all PCI cases) within their first year of certification to be included in the California Elective PCI Program Report as a "certified hospital" for that calendar year. This threshold allows for recently certified hospitals to establish their programs prior to inclusion in a public report and increases the statistical reliability of the results. Of the 17 hospitals certified by 2018 Q4, 13 hospitals met this criterion.

Non-Program Hospitals: Non-Program hospitals include: 1) General acute care California hospitals that perform PCIs *with* cardiac surgery on-site and voluntarily report all PCI cases to NCDR (OSHPD receives a statewide *de-identified* dataset from NCDR that includes data for these hospitals) and 2) certified hospitals that perform fewer than 100 PCIs (all PCI cases) within their first year of certification. Of the 118 non-program hospitals that submitted their data to NCDR in 2018, four certified hospitals met this criterion.

PCI Outcomes:

> **Mortality:** The number of deaths that occurred in the hospital after PCI for the time period indicated regardless of length of stay or patient status (i.e., inpatient or outpatient).

> **Post-PCI Stroke:** The number of post-PCI ischemic or hemorrhagic strokes that were unresolved after 24 hours (restricted to 30 days after last procedure) or a stroke with documentation on imaging (e.g., CT scan or MRI of hemorrhage in cerebral parenchyma, or a subdural or subarachnoid hemorrhage) for the time period indicated.

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[4] Specific clinical definitions are derived from the NCDR CathPCI Registry v. 4.4 Data Dictionary – Full Specifications.

Post-PCI ECAB: The number of post-PCI emergency or salvage CABG surgeries that occurred in hospital (including transfers to other acute general care hospitals) for the time period indicated.

Observed Outcome Rate: The ratio of the number of PCI cases with an outcome (i.e., mortality, post-PCI stroke, or post-PCI ECAB) and the number of PCI cases multiplied by 100: Observed Outcome Rate = PCI cases with Outcome/PCI Cases x 100.

Expected Outcome Rate: The ratio of expected outcomes predicted for a provider (after risk adjusting for the provider's patient population) and the number of PCI cases multiplied by 100: Expected Outcome Rate = Expected Outcomes/PCI Cases x 100.

Risk-Adjusted Outcome Rate (95% CI): The risk-adjusted outcome rate (Mortality Rate [RAMR]; Post-PCI Stroke Rate [RASR]) is obtained by multiplying the California statewide (i.e., certified and non-program hospitals) observed outcome rate by the provider's relevant Observed/Expected ratio. For elective PCIs only, the 95% confidence interval represents the confidence in the estimate for the risk-adjusted rate. The lower and upper confidence limits are calculated using the Poisson exact confidence interval calculations.

Identified Outlier: For elective PCIs only, an identified outlier is based on a comparison of the 95% CIs of a provider's risk-adjusted outcome rate to the statewide observed outcome rate. This is a test of statistical significance. An outlier is considered positive if the upper 95% CI of its risk-adjusted outcome rate falls below the statewide observed outcome rate. An outlier is considered negative if the lower 95% CI of its risk-adjusted outcome rate falls above the statewide observed outcome rate. If the statewide observed outcome rate falls within the 95% CI of a provider's risk-adjusted outcome rate, the provider is not identified as an outlier.

Appendix B: Certified Hospital Full Year 2018 Cases and Outcomes

Table E-1: Certified Hospital Full Year 2018 (Q1-Q4) All PCI Cases and Outcomes

Certified Hospital	All PCI Cases	Mortality	Post-PCI Stroke	Post-PCI ECAB
Clovis Community Medical Center	269	4	0	1
Emanuel Medical Center (Turlock)	301	6	0	2
Highland Hospital (Oakland)	171	7	1	0
Kaiser Foundation Hospital - Orange County - Irvine	406	0	0	0
Kaiser Foundation Hospital -Roseville	586	6	0	4
Kaiser Foundation Hospital - San Jose	140	10	0	0
Kaiser Foundation Hospital - South Sacramento	512	11	2	0
Kaiser Foundation Hospital - Walnut Creek	223	4	0	1
Kaiser Foundation Hospital & Rehab Center - Vallejo	360	3	6	0
Los Alamitos Medical Center	228	11	0	0
St. Rose Hospital (Hayward)	224	10	2	0
Sutter Delta Medical Center (Antioch)	271	9	1	0
Sutter Roseville Medical Center	413	7	1	0
Totals	**4,104**	**88**	**13**	**8**

Table E-2: Certified Hospital Full Year 2018 (Q1-Q4) Elective PCI Cases and Outcomes

Certified Hospital	Elective PCI Cases	Mortality	Post-PCI Stroke	Post-PCI ECAB
Clovis Community Medical Center	155	0	0	0
Emanuel Medical Center (Turlock)	33	0	0	0
Highland Hospital (Oakland)	12	0	0	0
Kaiser Foundation Hospital - Orange County - Irvine	164	0	0	0
Kaiser Foundation Hospital -Roseville	126	0	0	0
Kaiser Foundation Hospital - San Jose	14	0	0	0
Kaiser Foundation Hospital - South Sacramento	91	0	0	0
Kaiser Foundation Hospital - Walnut Creek	73	0	0	0
Kaiser Foundation Hospital & Rehab Center - Vallejo	98	0	0	0
Los Alamitos Medical Center	73	1	0	0
St. Rose Hospital (Hayward)	27	0	0	0
Sutter Delta Medical Center (Antioch)	34	0	0	0
Sutter Roseville Medical Center	87	0	0	0
Totals	**987**	**1**	**0**	**0**

Appendix C: Acknowledgments

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