

Risk-Adjusted 30-Day Readmission Rates for
Percutaneous Coronary Interventions

PCI 2011

Introduction

For over twenty years, the NYS Cardiac Data Reporting System has been a powerful resource for quality improvement in the areas of cardiac surgery and percutaneous coronary interventions (PCI). Building on this strong foundation, we are pleased to now present for the first time risk-adjusted 30-day readmission rates for PCI patients.

Annual reports on PCI outcomes in NYS, publically released for many years, have provided valuable information to patients and health care providers concerning mortality outcomes after PCI. This new report serves as a complement to the existing mortality reports. Readmissions data are regarded as an important measure of hospital quality and resource utilization, and are currently being reported by the federal Center for Medicare and Medicaid Services for a few medical conditions for Medicare patients. The data provided here serve as an additional factor that patients and referring providers may consider when developing treatment plans. Patients are encouraged to discuss this information with their health care provider.

This report was developed with clinical guidance from the NYS Cardiac Advisory Committee, an advisory body to the Commissioner of Health consisting of nationally recognized cardiac surgeons, cardiologists and others from related disciplines working both in New York State and elsewhere. The Cardiac Advisory Committee is to be commended for sustained leadership in these efforts.

The data that serve as the basis for these reports is collected by the NYS Department of Health cooperatively with hospitals throughout the state. Careful auditing and rigorous analysis assure that the results contained in these reports represent meaningful outcome assessments. Hospitals and physicians in NYS can take pride in the excellent patient care provided and in their role in contributing to this unique, collaborative, quality improvement system.

Patient Population

This report is based on data for patients discharged between December 1, 2010, and November 30, 2011, provided by all 59 non-federal hospitals in NYS where percutaneous coronary interventions (PCI, also known as angioplasty or coronary stenting) were performed. PCI is one type of procedure used to treat coronary artery disease. During a PCI procedure, a catheter is threaded up to the site of the blockage in a coronary artery. In conjunction with the catheter, devices are used to open the blockage.

In total there were 50,530 PCI procedures performed during this time period. As more fully described in the mortality report, 293 cases were excluded from all analyses for reasons including pre-procedural risk of shock, out-of-country residence, and anoxic brain injury mortality. This left 50,237 cases to be considered for analysis of readmission. For various reasons, some additional cases are excluded from analysis in this report. The reasons for exclusion and number of cases affected are described below.

Records belonging to patients residing outside NYS were excluded because there is no reliable way to track out-of state readmissions. This accounted for 1867 cases. Another 275 patients were excluded because they died in the same admission as their index PCI, so readmission was impossible. Twenty patients were transferred to another hospital and died there.

No second readmissions of patients who were readmitted for PCI within 30 days were counted. This resulted in an additional 2,353 exclusions. Finally, 17 patients were excluded because they were initially transferred to another acute care facility and their final discharge was after November 30, 2011. These patients could not be followed for 30 days because of the lack of 2012 data at the time of analysis.

In total, the number of exclusions was 4,805, leaving 45,705 cases to be examined for 30-day readmission.

Data Collection, Data Validation and Identifying 30-Day Readmission Rates

As more fully described in the mortality report, approximately 40 risk factors relating to patients' demographic and clinical characteristics are collected by hospitals' cardiac catheterization laboratories. Along with information about the hospital, physician and the patient's status at discharge, these data are entered into the Percutaneous Coronary Interventions Reporting System (PCIRS) database and sent to the Department of Health for analysis. Data are verified through review of unusual reporting frequencies, cross-matching of PCIRS data with other Department of Health databases and a review of medical records for a sample of cases.

Data on readmission are obtained from the Department of Health's acute care hospital dataset, the Statewide Planning and Research Cooperative System (SPARCS), which contains data pertaining to all acute care hospital discharges in the state. In addition, PCIRS is used to identify patients who underwent repeat PCI within 30 days but were not recorded in SPARCS because the procedure was technically considered an outpatient procedure.

Thirty-day readmission is defined as admission to a NYS non-Federal hospital within 30 days of discharge from the index hospitalization when the second admission is not for the purpose of staged PCI. For patients whose index hospitalization ends in transfer to another acute care facility, the 30 day period begins upon discharge from the second hospital. Also categorized as readmission is any non-staged PCI within 30 days of discharge, even if the second procedure is technically performed on an outpatient basis.

Admission for staged PCI or CABG is not counted in this analysis as a readmission. Staged PCI occurs when the overall treatment plan at the time of the first procedure includes an expectation for the patient to return at a later date for an additional PCI. To classify a subsequent PCI as part of a staged procedure, the hospital must be able to demonstrate the following: 1) At the time of the first PCI there was a plan for the patient to return for another PCI as part of the overall treatment strategy, 2) At the time of the second PCI there is an indication that the procedure is in follow-up to an earlier PCI as part of a staged treatment strategy, 3) None of the lesions treated in the first PCI are treated again in the second PCI, 4) The second PCI is not performed on an emergency basis due to a myocardial infarction (heart attack) or other cardiac emergency. Staged procedures involving PCI followed by CABG are much more rare, but the definition of staging is similar. There were 1281 staged PCIs and 26 staged CABGs that were not counted as readmissions.

Assessing Patient Risk and Predicting 30-Day Readmission Rates for Providers

Patient risk of 30-day readmission is assessed using the same methods used for assessing mortality risk. All potential risk factors are considered and the ones that are independently related to readmission are identified and given weights so as to best predict the risk of 30-day readmission for each patient. These probabilities are used to calculate the expected readmission rate (ERR) for each hospital by adding the predicted probabilities of readmission for each of the provider's patients and dividing by the number of patients. The resulting rate is an estimate of what the provider's readmission rate would have been if the hospital's performance was identical to the state performance. Each hospital's ERR is then contrasted with its observed readmission rate (ORR), which is the number of PCI patients who were readmitted within 30 days divided by the total number of PCI patients in the analysis.

To calculate the risk-adjusted readmission rate (RARR), the ORR for each provider is first divided by the provider's ERR, and this ratio is then multiplied by the overall statewide readmission rate (11.08 percent in 2011). The RARR represents the best estimate, based on the associated statistical model, of what the provider's 30-day readmission rate would have been if the provider had a mix of patients identical to the statewide mix. Thus, the RARR has, to the extent possible, ironed out differences among providers in patient severity of illness, since it arrives at a readmission rate for each provider based on an identical group of patients.

Interpreting the Risk-Adjusted Readmission Rate

This analysis is based on all-cause readmission not just readmission directly related to the PCI procedure. Not all readmissions represent a poor patient outcome or reflect poor patient care. However, by risk-adjusting and comparing the results across the many hospitals that perform this procedure we are able to look for meaningful differences from the overall statewide experience.

If the RARR is significantly lower than the statewide readmission rate, the hospital has a better performance than the state as a whole; if the RARR is significantly higher than the statewide readmission rate, the hospital has a worse performance than the state as a whole.

The RARR is used in this report as a measure of quality of care provided by hospitals. However, there are reasons that a provider's RARR may not be indicative of its true quality, just as risk-adjusted mortality rates (RAMRs) may not be indicative of true quality. For example, extreme outcome rates may occur due to chance alone. This is particularly true for low-volume providers, for whom very high or very low rates are more likely to occur than for high-volume providers. To prevent misinterpretation of differences caused by chance variation, expected ranges (confidence intervals) are included in the reported results. Differences in hospital coding of risk factors could be an additional reason that a hospital's RARR may not be reflective of quality of care. The Department of Health monitors the quality of coded data by reviewing patients' medical records to ascertain the presence of key risk factors. When significant coding problems are discovered, hospitals are required to correct these data and are subject to subsequent monitoring.

How This Initiative Contributes to Quality Improvement

One goal of the Department of Health and the Cardiac Advisory Committee is to improve the quality of care in relation to cardiac surgery and PCI in NYS. Providing the hospitals, cardiac surgeons (who perform cardiac surgery) and cardiologists (who perform PCI) in NYS with data about their own outcomes for these procedures allows them to examine the quality of their own care and to identify opportunities to improve that care.

The data collected and analyzed in this program are reviewed by the Cardiac Advisory Committee, which assists with interpretation and advises the Department of Health regarding which hospitals and physicians may need special attention. Committee members have also conducted site visits to particular hospitals and have recommended that some hospitals obtain the expertise of outside consultants to design improvements for their programs.

2011 Hospital Risk-Adjusted Readmission for PCI

Table 1 presents the PCI 30-day readmission results for the 59 hospitals performing PCI in NYS in 2011 for which data could be analyzed. The table contains, for each hospital, the number of PCIs resulting in 2011 discharges, the number of 30-day readmissions, the ORR, the ERR based on the statistical model presented in Appendix 1, the RARR and a 95 percent confidence interval for the RARR. The overall 30-day ORR for the 45,705 PCIs included in this 2011 analysis was 11.08 percent. Observed readmission rates ranged from 3.90 percent to 18.83 percent. The range in ERRs, which measure patient severity of illness, was between 9.02 percent and 13.83 percent. The RARRs, which measure hospital performance, range from 4.06 percent to 17.52 percent.

Based on confidence intervals for RARRs, seven hospitals (Good Samaritan Hospital Medical Center in West Islip, Long Island Jewish Medical Center in New Hyde Park, Lutheran Medical Center in Brooklyn, St. Catherine of Siena Hospital in Smithtown, University Hospital-Brooklyn, Westchester Medical Center, and White Plains Hospital) had RARRs that were significantly higher than the statewide average. Seven hospitals (Cayuga Medical Center in Ithaca, Ellis Hospital in Schenectady, Erie County Medical Center in Buffalo, Millard Fillmore Hospital in Buffalo, New York Presbyterian @ Columbia Presbyterian Medical Center in Manhattan, Strong Memorial Hospital in Rochester and United Health Services-Wilson in Johnson City) had RARRs that were significantly lower than the statewide average. Please note that Erie County Medical Center stopped performing PCI in February 2013 and Millard Fillmore Hospital closed in March 2012.

Definitions of key terms are as follows:

The observed readmission rate (ORR) is the observed number of 30-day readmissions divided by the total number of analyzed cases.

The expected readmission rate (ERR) is the sum of the predicted probabilities of readmission for all patients divided by the total number of analyzed cases.

The risk-adjusted readmission rate (RARR) is the best estimate, based on the statistical model, of what the provider's readmission rate would have been if the provider had a mix of patients similar to the statewide mix. It is obtained by first dividing the ORR by the ERR, and then multiplying that quotient by the statewide readmission rate (11.08 percent 30-day readmission rate for all PCI patients discharged in 2011).

Confidence intervals indicate which hospitals had significantly more or fewer readmissions than expected given the risk factors of their patients. Hospitals with significantly higher rates than expected after adjusting for risk are those with confidence intervals entirely above the statewide rate. Hospitals with significantly lower rates than expected, given the severity of illness of their patients before the PCI, have confidence intervals entirely below the statewide rate.

Table 1

Hospital Observed, Expected and Risk-Adjusted Readmission Rates for All PCI in New York State, 2011 Discharges

Hospital	Cases	Readmissions	ORR	ERR	RARR	95% CI for RARR
Albany Medical Center	911	87	9.55	10.10	10.48	(8.39, 12.92)
Arnot Ogden Med Ctr	430	42	9.77	10.59	10.22	(7.36, 13.81)
Bellevue Hospital Ctr	444	57	12.84	11.83	12.02	(9.10, 15.58)
Beth Israel Med Ctr	1344	156	11.61	10.50	12.25	(10.4, 14.33)
Bronx-Lebanon-Cncourse	64	10	15.63	11.82	14.65	(7.01, 26.95)
Brookdale Hosp Med Ctr	190	23	12.11	13.83	9.69	(6.14, 14.55)
Buffalo General Hosp	1121	133	11.86	10.94	12.02	(10.1, 14.24)
Cayuga Med Ctr Ithaca	154	6	3.90	10.64	4.06 **	(1.48, 8.83)
Champ. Valley Phys Hosp	706	84	11.90	10.83	12.18	(9.71, 15.07)
Crouse Hospital	357	32	8.96	10.45	9.50	(6.50, 13.42)
Ellis Hospital	493	38	7.71	10.59	8.07 **	(5.71, 11.07)
Elmhurst Hospital Ctr	432	50	11.57	10.34	12.40	(9.20, 16.34)
Erie County Med Ctr	150	9	6.00	11.57	5.75 **	(2.62, 10.91)
Faxton - St. Lukes	260	24	9.23	9.62	10.63	(6.81, 15.81)
Glens Falls Hospital	216	15	6.94	9.20	8.36	(4.68, 13.79)
Good Sam - Suffern	515	69	13.40	11.68	12.71	(9.89, 16.09)
Good Sam - West Islip	617	81	13.13	9.02	16.12 *	(12.8, 20.04)
Huntington Hospital	243	33	13.58	10.58	14.22	(9.79, 19.97)
Jamaica Hosp Med Ctr	204	32	15.69	11.47	15.15	(10.4, 21.38)
Lenox Hill Hospital	1630	198	12.15	10.92	12.32	(10.7, 14.16)
Long Island Jewish MC	1721	223	12.96	11.16	12.86 *	(11.2, 14.66)
Lutheran Medical Ctr	308	58	18.83	11.91	17.52 *	(13.3, 22.64)
M I Bassett Hospital	316	28	8.86	10.46	9.39	(6.24, 13.57)
Maimonides Medical Ctr	1006	125	12.43	12.10	11.37	(9.47, 13.55)
Mercy Hospital	653	59	9.04	10.77	9.30	(7.08, 11.99)
Millard Fillmore Hosp	616	51	8.28	10.99	8.34 **	(6.21, 10.97)
Montefiore - Moses	597	67	11.22	11.09	11.21	(8.69, 14.24)
Montefiore - Weiler	510	68	13.33	11.79	12.53	(9.73, 15.88)
Mount Sinai Hospital	4013	430	10.72	11.55	10.28	(9.33, 11.30)
NY Hospital - Queens	656	55	8.38	10.39	8.94	(6.74, 11.64)
NY Methodist Hospital	1372	168	12.24	10.97	12.37	(10.6, 14.38)
NYP- Columbia Presby.	2366	217	9.17	11.43	8.89 **	(7.74, 10.15)
NYP- Weill Cornell	1168	137	11.73	12.12	10.72	(9.00, 12.67)
NYU Hospitals Center	988	105	10.63	9.87	11.93	(9.76, 14.44)
North Shore Univ Hosp	1525	158	10.36	10.99	10.44	(8.88, 12.20)
Orange Regional Med Ctr	501	57	11.38	10.51	12.00	(9.09, 15.55)
Rochester General Hosp	1545	163	10.55	10.97	10.65	(9.08, 12.42)
South Nassau Com. Hosp	529	63	11.91	11.23	11.75	(9.03, 15.03)
Southside Hospital	515	63	12.23	9.98	13.58	(10.4, 17.37)

Hospital	Cases	Readmissions	ORR	ERR	RARR	95% CI for RARR
St. Barnabas Hospital	48	8	16.67	11.62	15.89	(6.84, 31.32)
St. Catherine of Siena	244	38	15.57	10.64	16.21 *	(11.5, 22.26)
St. Elizabeth Med Ctr	769	76	9.88	11.44	9.57	(7.54, 11.98)
St. Francis Hospital	2444	253	10.35	11.20	10.24	(9.02, 11.58)
St. Josephs Hospital	2015	227	11.27	11.28	11.07	(9.68, 12.61)
St. Lukes Crnwll-Newbrg	302	33	10.93	12.67	9.55	(6.58, 13.42)
St. Lukes at St. Lukes	451	40	8.87	11.88	8.27	(5.91, 11.26)
St. Peters Hospital	740	66	8.92	10.58	9.34	(7.22, 11.89)
Staten Island Univ Hosp	915	89	9.73	10.46	10.31	(8.28, 12.68)
Strong Memorial Hosp	859	73	8.50	10.69	8.81 **	(6.90, 11.07)
UHS - Wilson Med Ctr	696	51	7.33	11.10	7.31 **	(5.45, 9.62)
Unity Hospital	230	21	9.13	10.22	9.90	(6.12, 15.13)
Univ. Brooklyn @ LICH	168	29	17.26	12.35	15.49	(10.4, 22.24)
Univ. Hosp-Brooklyn	401	68	16.96	12.65	14.86 *	(11.5, 18.84)
Univ. Hosp-Stony Brook	1381	185	13.40	11.75	12.63	(10.9, 14.59)
Univ. Hosp-Upstate	265	21	7.92	11.71	7.50	(4.64, 11.46)
Vassar Bros. Med Ctr	604	70	11.59	10.36	12.39	(9.66, 15.66)
Westchester Med Ctr	685	100	14.60	11.33	14.28 *	(11.6, 17.37)
White Plains Hospital	222	38	17.12	11.19	16.95 *	(12.0, 23.27)
Winthrop Univ. Hosp	880	104	11.82	10.82	12.10	(9.89, 14.67)
Total	45705	5064	11.08			

* Risk-adjusted readmission rate significantly higher than statewide rate based on 95 percent confidence interval.

** Risk-adjusted readmission rate significantly lower than statewide rate based on 95 percent confidence interval.

2011 Risk Factors For PCI 30-Day Readmission

The significant pre-procedural risk factors for 30-day readmissions following PCI in 2011 are presented in the table that follows.

For risk factors that are binary (e.g., has the condition, does not have it), the odds ratio for the risk factor represents the number of times a patient with that risk factor is more likely to be readmitted to any acute care hospital in New York within 30 days after discharge following PCI than a patient without the risk factor, all other risk factors being the same. For example, the odds ratio for the risk factor "Cerebrovascular Disease" is 1.324. This means that a patient with cerebrovascular disease is approximately 1.324 times as likely to be readmitted to a hospital within 30 day following discharge after PCI as a patient without cerebrovascular disease who has the same other significant risk factors. The risk factors Female, Black, Two or Three Vessels Diseased, Peripheral Vascular Disease, Malignant Ventricular Arrhythmia, COPD, and Diabetes are also interpreted in the same way.

Age has a more complicated relationship with readmission rate, and is represented by both a linear and a quadratic (squared) term. This represents the fact that as patients age, their risk of 30-day readmission increases at an increasing rate. This functional form is used to improve the model's ability to predict readmissions, but it means that the odds ratios for these terms do not have a straightforward interpretation. Therefore these odds ratios are not contained in the table.

Ejection Fraction, which is the percentage of blood in the heart's left ventricle that is expelled when it contracts (with more denoting a healthier heart), is subdivided into three ranges (less than 20 percent, 20 to 39 percent, and 40 percent or more). The last range is referred to as the reference category. This means that the odds ratio that appears for the other Ejection Fraction categories in the table is relative to patients with an ejection fraction of 40 percent or more. Thus, a PCI patient with an ejection fraction of less than 20 percent is about 1.52 times as likely to be readmitted to a hospital within 30 days as a patient with an ejection fraction of 40 percent or higher, all other significant risk factors being the same.

Previous MI is subdivided into four categories: ST elevation myocardial infarction (STEMI) within 24 hours, non-ST-elevation myocardial infarction (NSTEMI) within 24 hours, any myocardial infarction (MI) between 1 and 20 days, and no MI within 20 days prior to the PCI. The odds ratios given for the first three of these categories are relative to the fourth category, which is the reference.

Renal Failure is subdivided into six groups. Four categories represent patients with various levels of elevated creatinine, but no dialysis. One category includes patients with renal failure on dialysis. These groups are relative to patients who are not on dialysis and had no pre-PCI creatinine values greater than 1.2 mg/dL.

Congestive heart failure (CHF) is subdivided into three categories: No CHF within 6 months, CHF – Current (within 2 weeks), CHF – Past (within 6 months but not within 2 weeks of PCI). The odds ratios for "current" and "past" are relative to patients with no CHF within the past 6 months.

Appendix Table 1
Multivariate Risk Factor Equation for PCI 30-Day Readmission in
New York State, 2011.

Patient Risk Factors	Prevalence (%)	Regression Coefficient	P value	OR
Demographic				
Age	—	-0.0655	<.0001	--
Age – squared	—	0.0551	<.0001	--
Female	31.21	0.2773	<.0001	1.320
Black	10.57	0.1387	0.0030	1.149
Ventricular Function				
Ejection Fraction				
Ejection Fraction 40% or greater	88.41	— Reference —		1.000
Ejection Fraction less than 20%	0.71	0.4160	0.0032	1.516
Ejection Fraction 20-39%	10.88	0.1391	0.0029	1.149
Pre-Procedural MI				
No MI within 20 Days	70.34	— Reference —		1.000
STEMI within 24 hours	11.51	0.3567	<.0001	1.429
NSTEMI within 24 hours	3.87	0.2170	0.0056	1.242
MI 1-20 days	14.27	0.2477	<.0001	1.281
Comorbidities				
Cerebrovascular Disease	8.75	0.2810	<.0001	1.324
Peripheral Vascular Disease	9.32	0.2427	<.0001	1.275
Congestive Heart Failure				
None within 6 months	91.16	— Reference —		1.000
Current (within 2 weeks)	5.35	0.6140	<.0001	1.848
Past (between 2 weeks and 6 months)	3.49	0.2875	<.0001	1.333
Malignant Ventricular Arrhythmia	0.67	0.5108	0.0006	1.667
COPD	6.49	0.3595	<.0001	1.433
Diabetes	35.24	0.1683	<.0001	1.183
Renal Failure				
No Renal Failure	69.59	— Reference —		1.000
Creatinine \geq 1.2 and \leq 1.5 mg/dL	20.52	0.0799	0.0412	1.083
Creatinine $>$ 1.5 and \leq 2.0 mg/dL	5.33	0.1914	0.0024	1.211
Creatinine $>$ 2.0 and \leq 2.5 mg/dL	1.16	0.4393	0.0001	1.552
Creatinine $>$ 2.5 mg/dL	1.01	0.5631	<.0001	1.756
Renal Dialysis	2.38	0.8674	<.0001	2.381
Vessels Diseased				
Two or three vessels diseased	44.82	0.2305	<.0001	1.259

Intercept = -0.8576

C Statistic = 0.638