**Comparison of 30-day Unplanned Readmissions to the Index Versus Non-Index Hospital After Percutaneous Coronary Intervention**

Running title: Index and non-index readmissions after PCI

Chun Shing Kwok MBBS MSc BSc,1,2 Ankur Kalra MD,3 Poonam Velagapudi MD MS,4 Ki Park MD,5 Mohamed Mohamed MB BCh,1,2 M Chadi Alraies MD,6 Richard K Cheng MD MS,7 Rodrigo Bagur MD PhD,1 Mamas A. Mamas BM BCh DPhil1,2

1. Keele Cardiovascular Research Group, Keele University, Stoke-on-Trent, UK

2. Royal Stoke University Hospital, Stoke-on-Trent, UK

3. Department of Cardiovascular Medicine, Heart and Vascular Institute, Cleveland Clinic, Cleveland, Ohio, USA.

4. Division of Cardiovascular Medicine, University of Nebraska Medical Center, Omaha, Nebraska, USA.

5. Division of Cardiovascular Medicine, University of Florida, Florida, USA.

6. Wayne State University, Detroit Medical Center, Detroit Heart Hospital, Detroit, Michigan, USA.

7. Division of Cardiology, University of Washington Heart Institute, Seattle, Washington, USA.

**Corresponding author**

Professor Mamas A. Mamas

Keele Cardiovascular Research Group, Keele University, Stoke-on-Trent, UK

Email: [mamasmamas1@yahoo.co.uk](mailto:mamasmamas1@yahoo.co.uk), Twitter handle: @MMamas1973

**Tel:** +44 1782 671654 **Fax:** +44 1782 674467

**List of Supports/Grants Information:** The study was supported by a grant from the Research and Development Department at the Royal Stoke Hospital. This work is conducted as a part of PhD for CSK which is supported by Biosensors International.

**Acknowledgements:** We are grateful to the Healthcare Cost and Utilization Project (HCUP) and the HCUP Data Partners for providing the data used in the analysis.

**Conflicts of interest disclosures:** The authors have no conflicts of interest to declare.**Abstract**

There is limited information about readmissions to index compared with non-index hospitals after PCI. This study aims to evaluate the rates, causes, and outcomes for unplanned readmissions following percutaneous coronary intervention (PCI) depending on whether the patients were admitted to the index or non-index hospital. Patients undergoing PCI between 2010 and 2014 in the U.S. Nationwide Readmission Database were evaluated for unplanned readmissions at 30 days to index and non-index hospitals. A total of 2,183,851 procedures were analyzed, with a 9.2% 30-day unplanned readmission rate documented, and 7.1% and 2.1% of these readmissions were admitted to the index and non-index hospitals, respectively. There was also a higher prevalence of co-morbidities among patients readmitted to non-index hospitals, and more patients who were discharged against medical advice at index PCI. Non-cardiac readmissions were lower among patients who were readmitted to the index compared with non-index hospital (53.4% vs. 61.1%, p<0.001). There were greater adjusted odds of acute myocardial infarction (AMI) (OR 1.14 95%CI 1.06-1.22), PCI (OR 2.25 95%CI 2.06-2.46) and composite outcome (AMI, readmission PCI and all-cause death) (OR 1.64 95%CI 1.53-1.75) for patients readmitted to the index hospital but their odds of all-cause death were lower (OR 0.77 95%CI 0.68-0.88). The majority of readmissions after PCI are to the index hospital that the PCI was undertaken, and these patients are more likely to have a readmission diagnosis of AMI and undergo a repeat PCI but less likely to die compared with patients admitted to a non-index hospital.

**Keywords:** percutaneous coronary intervention; readmission; mortality

**Introduction**

Readmissions after percutaneous coronary intervention (PCI) are a burden to patients and healthcare services, and are potentially avoidable.1 It is unclear whether patients that have an unplanned readmission following PCI are more or less likely to be readmitted to the same hospital as their index PCI or to a different one, and whether the causes for such readmissions and their clinical outcomes differ. A previous analysis of patients from 2 hospitals reported that 9.8% were readmitted following a PCI procedure within 30-days.2 They reported that two-thirds of patients were readmitted to the same hospital at which the PCI was performed with the causes of readmission differing depending on whether the patient returned to the index hospital. This study was limited as it only included data derived from 2 hospitals and so its relevance to the wider healthcare setting is uncertain, and also included staged PCI procedures which should not be considered as unplanned readmissions. To better understand readmissions to the same or different hospitals after PCI, we conducted an analysis of the Nationwide Readmission Database to evaluate the rates, causes, and outcomes for readmission depending on whether the patients were admitted to the index or non-index hospital.

**Methods**

The Nationwide Readmission Database (NRD) developed by the Healthcare Cost and Utilization Project is a database which supports analyses of national readmission rates for all payers and insurers.3 For the period of the NRD where this analysis was performed, the database is constructed from discharge level data of hospitalizations from 21 geographically dispersed participating states which represent 49.3% of the total U.S. population.1 A de-identified unique patient linkage number assigned to each patient is used to track readmission hospitals within a state during a calendar year.

For each hospitalization episode, individual patients in the NRD dataset are assigned up to 15 procedure codes. The cohort with percutaneous coronary intervention (PCI) was defined by the International Classification of Diseases-9th Revision (ICD-9) procedural codes 0066 (PTCA OR: CORONARY ATHER), 3606 (INSERT CORON ART STENT), and 3607 (INSERT DRUGELUTING CRNRY AR). We excluded patients who died in-hospital during index PCI, patients with missing values for time to readmission, and patients who were transferred to other hospitals. In order to study unplanned readmissions, we excluded patients with readmissions that were classified as elective. As this study included more than one year and it was impossible to link patients across years, we excluded patients discharged in the month of December because these patients do not have complete 30-day follow-up for readmissions. The readmitted cohort was further split into those who were readmitted to index hospital, and those who were readmitted to non-index hospital.

The outcomes of this study were the rates of first unplanned readmissions to the index and non-index hospital within 30-days. In addition, we also considered readmissions at 7 days, 90 days and 180 days at index and non-index hospital. Also, we evaluated the causes of unplanned readmissions as well as outcomes for readmissions including length of stay, diagnosis of acute myocardial infarction (AMI), PCI, all-cause death and the composite of AMI, PCI, and death. The total cost of index admission and readmissions for each patient was determined by multiplying the hospital charges with the Agency for Healthcare Research and Quality’s all-payer cost-to-charge ratios for each hospital.

We used ICD-9 codes to define clinical variables including smoking status, dyslipidemia, coronary artery disease, previous myocardial infarction, previous PCI, previous coronary artery bypass grafting (CABG), previous stroke or transient ischemic attack (TIA), atrial fibrillation, dementia, and receipt of circulatory support. Additional comorbidity variables were derived from the Elixhauser Comorbidity Software codes available in the NRD,4 and these included alcohol misuse, chronic lung disease, heart failure, diabetes, valvular heart disease, peptic ulcer disease, hypertension, renal failure, obesity, cancer, fluid and electrolyte disorders, depression, peripheral vascular disease, hypothyroidism, liver disease, anemia, and coagulopathy. The paralysis variable from the Elixhauser comorbidities was used as a surrogate for hemiplegia. Using Clinical Classifications Software codes, connective tissue disease was defined by codes 210 and 2011 while leukemia was defined by code 39. The Charlson Comorbidity Index was derived from a combination of these comorbidity variables, and the number of co-morbidities was the sum of the co-morbidities included in the analysis. Procedural ICD-9 codes were used to define multi-vessel disease, bifurcation disease, circulatory support, vasopressor use, intra-aortic balloon pump use, fractional flow reserve use, intravascular ultrasound, and drug-eluting stent use. Diagnostic ICD-9 codes were used to define in-hospital outcomes including complete heart block, TIA or stroke, cardiogenic shock, cardiac arrest, acute kidney injury, major bleeding, blood transfusion, vascular complication, and emergency CABG. Additional data were collected on length of stay in hospital, hospital bed size, hospital location and hospital teaching status, and discharge destination. The causes of readmissions were determined by the first diagnosis based on Clinical Classification Software codes, which are presented in detail in Supplementary Table 1.

Statistical analysis was performed on Stata version 15.0 (StataCorp, College Station, Texas). As recommended by the Agency of Healthcare Research and Quality, the survey estimation commands were used to estimate the sample sizes in the analysis. A flow diagram was used to show the patient inclusion process, and the rate of readmissions to index and non-index hospitals over time was shown graphically. The proportion of patients with an unplanned readmitted to index and non-index hospitals at 7 days, 30 days, 90 days and 180 days was determined. Descriptive statistics are presented according to readmission to index and non-index hospital. The statistical differences between readmission to index and non-index hospital for continuous and categorical variables were compared using the *t* test and chi-square test, respectively. Multiple logistic regressions were used to identify independent variables associated with 30-day readmissions to index and non-index hospital after PCI. Further regressions were used to determine the odds of acute myocardial infarction, PCI, death, and the composite of AMI, PCI and death at readmission. The logistic regression models were adjusted for age, sex, year, elective admission, weekend admission, diagnosis of AMI, primary expected payer, median household income, smoking, alcohol misuse, dyslipidemia, hypertension, diabetes mellitus, obesity, heart failure, coronary artery disease, previous myocardial infarction, previous PCI, previous CABG, previous valve disease, atrial fibrillation, previous TIA or stroke, peripheral vascular disease, pulmonary circulatory disorder, peptic ulcer disease, chronic lung disease, chronic kidney disease, liver disease, hypothyroidism, fluid and electrolyte disorders, anemia, cancer, depression, dementia, hospital bed size, hospital location, hospital teaching status, multi-vessel disease, bifurcation lesion, circulatory support, vasopressor use, intra-aortic balloon pump use, fractional flow reserve, intravascular ultrasound use, drug-eluting stent, in-hospital complete heart block, TIA or stroke, cardiogenic shock, cardiac arrest, acute kidney injury, major bleeding, blood transfusion, vascular complications, emergency CABG, length of stay, and discharge destination. The causes of readmission within 30 days are presented in a figure format as noncardiac and cardiac. A flow diagram was used to describe patient outcomes (in-hospital death) for both admissions and readmissions. We conducted a sensitivity analysis adjusted for whether the readmission hospital had PCI facilities or not.

**Results**

A total of 2,183,851 patients were included in the analysis from 2,576,141 patients who underwent PCI in the NRD database between 2010 and 2014, (Supplementary Figure 1). The 30-day unplanned readmission rate was 9.2%, of which 7.1% were readmitted to the index hospital and 2.1% were readmitted to the non-index hospital. The time to readmission to the index hospital was on average a day shorter compared with readmission to a non-index hospital. The proportion of patients readmitted at 7 days, 30 days, 90 days and 180 days were 2.4%, 9.2%, 17.7% and 23.1%. Those readmitted to index hospital was much higher than non-index hospital at all follow up time points. The declining portion of readmissions to index hospital with increasing time points is shown in Figure 1.

The trends in the proportion of readmissions to index and non-index hospitals are shown in Supplementary Figure 2. Between 2010 and 2014, no major differences in trends for readmissions were observed.

The descriptive statistics of the PCI cohort according to readmission status, and by readmission to index and non-index hospitals are shown in Table 1. Patients readmitted to a non-index hospital were more likely to have had elective PCI at the index procedure. There was also a slightly higher prevalence of cardiac co-morbidities among patients readmitted to a non-index hospital. There was a greater proportion of patients with chronic lung disease, renal failure and anemia among patients readmitted to a non-index hospital. The comorbidity burden was greater among patients who were readmitted to the non-index hospital with a greater mean number of co-morbidities. No major absolute differences in proportions of index PCI variables were observed for peri-procedural events, length of stay, and cost comparing readmissions with index and non-index hospitals.

The adjusted odds of readmission to index and non-index hospital are shown in Supplementary Table 2. Female patients showed greater propensity compared with men to be readmitted to both index and non-index hospital. Patients who misused alcohol were more likely to be readmitted to a non-index hospital, but no difference was observed for index hospital. While co-morbidities were associated with readmissions to both index and non-index hospitals, in general the odds were greater for patients admitted to non-index hospitals (chronic lung disease, renal failure, anemia, cancer, and dementia). Patients who discharged against medical advice were more likely to be readmitted to a non-index hospital compared with an index hospital.

Overall, 55% of readmissions were attributed to non-cardiac reasons. The rate of non-cardiac readmissions was significantly lower among patients who were readmitted to an index hospital compared with those readmitted to a non-index hospital (Figure 2). The causes of readmissions are shown in Table 2. Patients readmitted to the index hospital had a greater proportion of patients with readmissions for coronary artery disease including angina although readmissions for non-cardiac causes were more commonly observed in the non-index hospital group.

The independent odds of adverse outcomes for the readmission for non-index compared with index hospital are shown in Figure 3/Table 3. There were greater adjusted odds of acute myocardial infarction (AMI), PCI and composite outcome (AMI, readmission PCI and all-cause death) for patients readmitted to the index hospital but their odds of all-cause death were lower.

The majority of readmissions were to hospitals with PCI facilities (93.3%). Among patients readmitted to non-index hospitals, 70.2% of these non-index hospitals had PCI facilities. Additional adjustments for whether or not the readmission hospital had PCI facilities changed the odds of readmission with AMI to the non-index hospital so that it was no longer statistically significant (OR 1.08 95%CI 1.00-1.17 versus OR 0.88 95%CI 0.82-0.95) (Supplementary Table 3).

**Discussion**

Our national evaluation of unplanned readmissions to index and non-index hospitals after PCI has several key findings. First, three-quarters of readmissions were to the hospital where the index PCI was performed. Second, patients admitted to a non-index hospital had more co-morbidities, and more likely to be readmitted for non-cardiovascular causes. Finally, the factor most strongly associated with readmission to a non-index hospital was discharge against medical advice. Patients readmitted to their index hospital were more likely to be readmitted with an AMI and undergo repeat PCI, but their in-hospital mortality rates for the readmission episode were lower. These findings suggest that there are important differences in clinical characteristics, causes of readmissions and clinical outcomes between patients readmitted to to index and non-index hospitals following a PCI, with a greater understanding for motivating factors around why patients / healthcare providers choose to seek medical attention elsewhere required.

Our current national analysis adds significantly to the findings of 2 the center study by Wasfy et al.2 The proportion of non-index hospital readmissions was higher in the Wasfy et al. study (32.8%) compared with the current study (22.6%). In addition, we report lower rates of readmission for chronic ischemic heart disease for both index and non-index hospitals which were 19.3% and 11.9%, respectively in the current study compared with 31.0% and 13.8%, respectively. The greater rate of readmissions for chronic ischemic heart disease may be potentially explained by inclusion of staged PCI procedures, which were excluded from the current study of unplanned readmissions. We were able to build on their findings considering differences in the characteristics of patients according to readmission to the index or non-index hospital as well as their readmission outcomes. In particular, it appears that patients that return to index hospital are less likely to die during the readmission but are more likely to be readmitted with an AMI or undergo a repeat PCI. In addition, compared with patients who are readmitted to an index hospital where the PCI took place, patients that are readmitted to a non-index hospital are more likely to have discharged against medical advice following the index PCI and have on average a greater burden of co-morbidities.

Several interesting observations can be made with regard to our results. First, the main analysis suggests that there is a 20% reduction in odds of readmission for AMI when readmitted to non-index compared to index hospital. However, in our sensitivity analysis which adjusted for PCI facilities the reduction is no longer significant. This suggests that the decrease in odds of readmissions at non-index hospitals is mainly driving by the lack of PCI facilities at these centers. Second, readmissions to the non-index hospital were associated with greater mortality. An explanation for this may relate to that fact that in emergent situations that require immediate medical attention, patients are transferred to the nearest hospital without considering whether it is the center that performed the index procedure. This is supported by the observation in the current analysis of slightly greater comorbidity among patients readmitted to non-index hospital, potentially making them higher risk but also slightly greater proportion of potentially life-threatening non-cardiac reasons for readmission such as infections (6.8% vs. 5.2%), respiratory illness (5.2% vs. 4.1%), bleeding (3.5% vs. 2.5%) and TIA/stroke (3.3% vs. 2.2%). Third, a vast majority of patients were readmitted to the index PCI hospital. It is likely that patients and their healthcare providers prefer continuity of care, and if they had a recent PCI, it is preferred to return to the same hospital that performed the index procedure. Fourth, we had previously studied discharge against medical advice in the context of PCI,5 and found that it was a very strong predictor of readmission. In our current analysis, discharge against medical advice was a very strong factor associated with readmission to a non-index hospital. This may be explained by a potential breakdown in the patient-physician relationship during the admission of the index PCI or a loss of trust when new symptoms occur post-discharge, influencing patients to seek an alternative opinion from another hospital.

The major benefit of return to index hospital is continuity of care. The benefits of continuity of care have been demonstrated in settings outside of PCI, and continuity of care is associated with increased patient satisfaction, savings in time to deliver care, increased patient control over their health, and patients perceive that care providers are more knowledgeable, thorough and interested in patient education.6 In the context of PCI, continuity of care is relevant as it is important to know which vessels were intervened upon, the nature of the disease, whether procedural difficulties were encountered, and whether there was any residual disease or concerns about peri-procedural complications. For example, untreated residual disease may cause symptoms of angina and result in readmissions.

Our study has several limitations related to the retrospective analysis of administrative data. A limitation of the current study is that we are not able to determine the distance from patient’s residence to hospital. This may be relevant as a potential main driver of the readmission hospital is the geographic distance from a patient’s residence where patients may prefer to go to the nearest hospital. Another limitation is that our results cannot account for the impact of transfer from community hospital to hospital where the PCI took place because the index hospital was considered to be that where the PCI took place. The construction of the NRD is such that we had to exclude patients admitted in the month of December to ensure that all patients had 30-days of follow-up. In addition, each year of NRD is completely independent from other years; therefore, a patient with PCI in each year that was studied may appear up to 5 times (once for each of the years between 2010 and 2014). As with any observational data, even though we included many variables, there may still be residual confounding. In addition, the NRD only contains hospital data; therefore, we do not have data on out-of-hospital deaths.

In conclusion, most patients readmitted within 30-day of PCI return to the index hospital where the PCI was performed. The patients who return to non-index hospitals appear to differ with regard to the proportion that were discharged against medical advice and misuse of alcohol, and there was a greater burden of co-morbidities compared with patients that are readmitted to the index hospital. There were key differences in outcomes for patients depending on whether they returned to index hospital as those who were readmitted to index hospital were more likely to have AMI or repeat PCI, while those who were readmitted to non-index hospital were more likely to die during the readmission.

**Contributorship:** MAM was responsible for the design and concept. CSK performed the data cleaning and analysis. CSK wrote the first draft of the manuscript and all authors contributed to the writing of the paper.

**References**

1. Kwok CS, Rao SV, Potts JE, Kontopantelis E, Rashid M, Kinnaird T, Curzen N, Nolan J, Bagur R, Mamas MA. Burden of 30-day readmissions after percutaneous coronary intervention in 833,344 patients in the United States: Predictors, Causes, and Costs. *JACC Cardiovasc Interv.* 2018;11:665-674.
2. Wasfy JH, Strom JB, O'Brien C, Zai AH, Luttrell J, Kennedy KF, Spertus JA, Zelevinsky K, Normand SL, Mauri L, Yeh RW. Causes of short-term readmission after percutaneous coronary intervention. *Circ Cardiovasc Interv.* 2014;7:97-103.
3. <https://www.hcup-us.ahrq.gov/nrdoverview.jsp>
4. <https://www.hcup-us.ahrq.gov/toolssoftware/comorbidity/comorbidity.jsp>
5. Kwok CS, Bell M, Anderson HV, Al Shaibi K, Gulati R, Potts J, Rashid M, Kontopantelis E, Bagur R, Mamas MA. Discharge Against Medical Advice After Percutaneous Coronary Intervention in the United States. *JACC Cardiovasc Interv.* 2018;11:1354-1364
6. Sudhakar-Krishnan V, Rudolf MCJ. How important is continuity of care? *Arch Dis Child.* 2007;92:381-383.

**List of Tables and Figures**

Table 1: Descriptive statistics for the PCI cohort according to unplanned readmission within 30 days.

Table 2: Causes of 30-day unplanned readmissions according to discharge to same or different hospital.

Table 3: Rates and adjusted odds of adverse outcomes for readmission to non-index compared with index hospital.

Figure 1: Proportion of readmissions to index hospital at different timing of follow up.

Figure 2: Proportion of patients with non-cardiac reasons for index versus non-index hospital readmissions.

Figure 3: Odds of adverse outcomes for readmission to index compared with non-index hospital.

Supplementary Table 1: Classification of Clinic Classification Software codes for Readmissions Causes

Supplementary Table 2: Factors associated with 30-day unplanned readmissions after PCI to the index or non-index hospital.

Supplementary Figure 1: Flow diagram of patient inclusion.

Supplementary Figure 2: Rate of readmissions to different and same hospital between 2010 and 2014.

**Table 1:** Descriptive statistics for the PCI cohort according to unplanned readmission within 30 days.

|  |  |  |  |
| --- | --- | --- | --- |
| Variable | No readmission (n=1,983,491) | Readmit non-index hospital (n=45,334) | Readmit index hospital (n=155,025) |
| Mean age (years, ±SD) | 64.1±12.2 | 66.3±12.8 | 66.2±12.7 |
| Women | 31.1% | 38.7% | 39.0% |
| Year  2010  2011  2012  2013  2014 | 22.1%  20.5%  19.1%  19.8%  18.5% | 23.8%  21.8%  19.1%18.5%  16.9% | 22.1%  21.1%  19.1%19.7%  18.1% |
| Elective index PCI | 17.3% | 15.9% | 10.4% |
| Weekend admission | 20.2% | 20.5% | 21.6% |
| Primary expected payer  Medicare  Medicaid  Private  Uninsured  No charge  Other | 50.4%  7.4%  31.8%  5.9%  0.8%  3.7% | 63.0%  10.2%  18.7%  4.7%  0.6%  2.9% | 61.0%  9.4%21.2%  4.3%  0.8%  3.3% |
| Median household income based on ZIP code  0-25th percentile  26-50th percentile  51-75th percentile  76-100th percentile | 28.7%  25.2%  24.0%  22.1% | 29.8%  25.0%  23.3%  22.0% | 31.3%  25.6%  23.2%  20.0% |
| Smoker | 42.2% | 41.9% | 39.9% |
| Alcohol misuse | 2.6% | 3.4% | 2.6% |
| Comorbidities |  |  |  |
| Dyslipidemia† | 69.9% | 69.9% | 69.1% |
| Hypertension | 74.4% | 79.5% | 77.6% |
| Diabetes mellitus | 35.7% | 46.0% | 43.5% |
| Obesity‡ | 15.9% | 16.9% | 15.9% |
| Previous heart failure | 1.0% | 2.2% | 1.8% |
| Previous coronary artery disease | 94.4% | 95.5% | 94.2% |
| Previous myocardial infarction | 14.2% | 17.8% | 15.1% |
| Previous PCI | 21.1% | 23.6% | 21.5% |
| Previous CABG | 7.7% | 10.6% | 9.0% |
| Previous heart valve disease | 0.3% | 0.8% | 0.6% |
| Atrial fibrillation | 10.3% | 17.3% | 16.4% |
| Previous stroke/TIA | 6.3% | 10.4% | 9.0% |
| Peripheral vascular disease | 10.4% | 17.0% | 14.6% |
| Pulmonary circulatory disorder | 0.2% | 0.4% | 0.4% |
| Peptic ulcer disease | 0.02% | 0.04% | 0.02% |
| Chronic lung disease | 15.6% | 25.5% | 23.1% |
| Renal failure | 11.7% | 23.9% | 21.1% |
| Liver disease | 1.2% | 2.2% | 1.8% |
| Hypothyroidism | 8.7% | 11.1% | 11.1% |
| Fluid and electrolyte disorder | 10.7% | 17.6% | 16.9% |
| Anemia | 9.4% | 20.2% | 17.1% |
| Cancer | 1.6% | 3.0% | 2.6% |
| Depression | 6.2% | 9.1% | 8.6% |
| Dementia | 1.3% | 2.8% | 2.3% |
| Mean Charlson comorbidity index (±SD) | 1.2±1.3 | 1.9±1.7 | 1.7±1.6 |
| Mean number of co-morbidities (±SD) | 4.8±2.0 | 5.7±2.3 | 5.4±2.2 |
| Hospital variables |  |  |  |
| Size based on number of beds  Small  Medium  Large | 5.8%  20.6%  73.6% | 6.5%  20.1%  73.5% | 4.6%  20.5%  74.9% |
| Urban classification | 99.8% | 99.8% | 99.8% |
| Teaching hospital | 54.9% | 57.7% | 53.2% |
| Procedural details |  |  |  |
| Multi-vessel disease | 16.1% | 16.1% | 16.2% |
| Bifurcation disease | 2.9% | 3.0% | 2.7% |
| Use of circulatory support | 2.4% | 3.8% | 3.6% |
| Use of vasopressor | 0.4% | 0.5% | 0.5% |
| Use of intra-aortic balloon pump | 2.2% | 3.4% | 3.2% |
| Use of fractional flow reserve | 1.9% | 2.2% | 2.0% |
| Use of intravascular ultrasound | 7.1% | 7.6% | 7.0% |
| Use of drug-eluting stent | 75.2% | 68.4% | 69.6% |
| Periprocedural events |  |  |  |
| Complete heart block | 0.9% | 1.1% | 1.0% |
| Stroke or TIA | 2.7% | 3.9% | 3.2% |
| Cardiogenic shock | 2.1% | 3.4% | 3.1% |
| Cardiac arrest | 1.4% | 1.6% | 1.6% |
| Acute kidney injury | 6.0% | 11.8% | 10.7% |
| Major bleeding | 0.5% | 0.9% | 0.9% |
| Blood transfusion | 0.04% | 0.04% | 0.08% |
| Vascular complication | 0.7% | 1.0% | 1.0% |
| Coronary artery bypass graft | 1.2% | 1.1% | 1.4% |
| Mean length of stay (days) (±SD) | 3.3±4.1 | 4.3±3.7 | 4.1±3.4 |
| Mean cost of index PCI (USD) (±SD) | $20,597±14,966 | $22,694±13,936 | $22,286±13,366 |
| Mean cost of readmission (USD) (±SD) | - | $12,459±20,296 | $11,459±15,067 |
| Mean cost of index PCI and readmission (USD) SD) | $20,597±14,966 | $34,933±25,650 | $33,730±21,804 |
| Discharge location  Home or self-care  Nursing facility  Discharge against medical advice | 92.8%  6.8%  0.4% | 84.5%  14.1%  1.4% | 85.5%  13.8%  0.7% |
| Readmission length of stay (days) | - | 4.5±6.2 | 4.0±4.9 |

CABG = coronary artery bypass graft, IQR = interquartile range, PCI = percutaneous coronary intervention, TIA = transient ischaemic attack, SD = standard deviation, USD = United States Dollars

†Dislipidemia defined by ICD-9 codes: 272.0 (pure hypercholesterolemia), 272.1 (pure hyperglyceridemia), 272.2 (mixed hyperlipidemia), 272.3 (hyperchylomicronemia) and 272.4 (other an unspecified hyperlipidemia)

‡Obesity defined by variable “CM\_OBESE” which is the AHRQ comorbidity measure for ICD-9-CM codes for obesity. This is explained in more detail on website: <https://www.hcup-us.ahrq.gov/db/vars/cm_obese/nisnote.jsp>

**Table 2:** Causes of 30-day unplanned readmissions according to discharge to same or different hospital.

|  |  |  |
| --- | --- | --- |
| **Causes of readmissions** | **Non-index hospital** | **Index hospital** |
| Cardiac causes for readmission | | |
| Coronary artery disease including angina | 11.9% | 19.3% |
| Heart failure | 10.5% | 9.7% |
| Acute myocardial infarction | 7.9% | 8.8% |
| Arrhythmias | 6.4% | 6.5% |
| Pericarditis | 0.5% | 0.6% |
| Valve disorders | 0.4% | 0.4% |
| Conduction disorders | 0.3% | 0.3% |
| Other cardiac | 0.9% | 1.0% |
| Non-cardiac causes for readmission | | |
| Non-specific chest pain | 9.1% | 10.5% |
| Infections | 6.8% | 5.2% |
| Gastrointestinal | 6.7% | 5.9% |
| Respiratory | 5.2% | 4.1% |
| Bleeding | 3.5% | 2.8% |
| TIA/stroke | 3.3% | 2.2% |
| Peripheral vascular disease | 2.3% | 2.5% |
| Neuropsychiatric | 2.3% | 1.1% |
| Renal failure | 2.1% | 1.8% |
| Hematological/neoplasm | 2.0% | 1.4% |
| Genitourinary | 2.0% | 1.4% |
| Trauma | 1.9% | 1.1% |
| Endocrine/metabolic | 1.8% | 1.2% |
| Syncope | 1.3% | 1.0% |
| Rheumatological | 1.1% | 0.9% |
| ENT problem | 1.0% | 0.7% |
| Poisoning | 0.3% | 0.3% |
| Dermatological | 0.1% | 0.1% |
| Oral health problem | 0.1% | 0.1% |
| Opthalmological | 0.1% | 0.0% |
| Obstetric or pregnancy problem | 0.0% | 0.1% |
| Hyper/hypotension | 0.0% | 0.0% |
| Other non-cardiac | 8.1% | 9.1% |

**Table 3: Rates and adjusted odds of adverse outcomes for readmission to non-index compared to index hospital.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Outcome during readmission | Rate in non-index hospital | Rate in index hospital | Odds ratio (95%CI) for admission to non-index hospital | p-value |
| Acute myocardial infarction | 9.2% | 8.3% | 0.88 (0.82-0.95) | 0.001 |
| PCI | 18.2% | 8.6% | 0.44 (0.41-0.49) | <0.001 |
| Death | 2.1% | 2.7% | 1.30 (1.14-1.48) | <0.001 |
| Composite of acute myocardial infarction, PCI, death | 23.9% | 15.7% | 0.61 (0.57-0.65) | <0.001 |

**Figure 1: Proportion of readmissions to index hospital at different timing of follow up.**



**Figure 2: Proportion of patients with non-cardiac reasons for index versus non-index hospital readmissions.**



**Figure 3: Odds of adverse outcomes for readmission to index compared with non-index hospital.**

****

**Supplementary Table 1:** Classification of Clinic Classification Software codes for Readmissions Causes

|  |  |  |
| --- | --- | --- |
| Causes of readmission | CCS code | Diagnosis |
| Respiratory | 127 | Chronic obstructive pulmonary disease and bronchiectasis |
| 128 | Asthma |
| 130 | Pleurisy, pneumothorax, pulmonary collapse |
| 131 | Respiratory failure, insufficiency and arrest |
| 132 | Lung disease due to external agents |
| 133 | Other lower respiratory disease |
| 134 | Other upper respiratory disease |
| 221 | Respiratory distress syndrome |
| Infection | 1 | Tuberculosis |
| 2 | Septicemia |
| 3 | Bacterial infection |
| 4 | Mycoses |
| 5 | HIV infection |
| 6 | Hepatitis |
| 7 | Viral infection |
| 8 | Other infection |
| 9 | Sexually transmitted infection |
| 76 | Meningitis |
| 77 | Encephalitis |
| 78 | Other CNS infection and poliomyelitis |
| 90 | Inflammation or infection of eye |
| 122 | Pneumonia |
| 123 | Influenza |
| 124 | Acute and chronic tonsillitis |
| 125 | Acute bronchitis |
| 126 | Other upper respiratory infections |
| 129 | Aspiration pneumonitis |
| 135 | Intestinal infection |
| 197 | Skin and subcutaneous tissue infections |
| 201 | Infective arthritis and osteomyelitis (except that caused by tuberculosis or sexually transmitted disease) |
| Bleeding | 60 | Acute posthemorrhagic anemia |
| 153 | Gastrointestinal hemorrhage |
| 182 | Hemorrhage during pregnancy; abrutio placenta; placenta previa |
| Peripheral vascular disease | 114 | Peripheral and visceral atherosclerosis |
| 115 | Aortic, peripheral and visceral artery aneurysms |
| 116 | Aortic and peripheral arterial embolism or thrombosis |
| 117 | Other circulatory disease |
| 118 | Phlebitis, thrombophlebitis and thromboembolism |
| 119 | Varicose veins of lower extremities |
| Genitourinary | 159 | Urinary tract infection |
| 160 | Calculus of the urinary tract |
| 161 | Other diseases of kidney and ureters |
| 162 | Other diseases of bladder and urethra |
| 163 | Genitourinary symptoms and ill-defined conditions |
| 164 | Hyperplasia of prostate |
| 165 | Inflammatory conditions of the male genital organs |
| 166 | Other male genital disorders |
| 170 | Prolapse of female genital organs |
| 175 | Other female genital disorders |
| 215 | Genitourinary congenital anomalies |
| Renal disease | 156 | Nephritis; nephrosis; renal sclerosis |
| 157 | Acute and unspecified renal failure |
| 158 | Chronic kidney disease |
| Gastrointestinal | 138 | Esophageal disorders |
| 139 | Gastroduodenal ulcer (except hemorrhage) |
| 140 | Gastritis and duodenitis |
| 141 | Other disorders of stomach and duodenum |
| 142 | Appendicitis and other appendiceal conditions |
| 143 | Abdominal hernia |
| 144 | Regional enteritis and ulcerative colitis |
| 145 | Intestinal obstruction without hernia |
| 146 | Diverticulosis and diverticulitis |
| 147 | Anal and rectal conditions |
| 148 | Peritonitis and intestinal abscess |
| 149 | Biliary tract disease |
| 150 | Liver disease; alcohol-related |
| 151 | Other liver diseases |
| 152 | Pancreatic disorders (not diabetes) |
| 154 | Noninfectious gastroenteritis |
| 155 | Other gastrointestinal disorders |
| 214 | Digestive congenital anomalies |
| 222 | Hemolytic jaundice and perinatal jaundice |
| 250 | Nausea and vomiting |
| 251 | Abdominal pain |
| TIA/stroke | 109 | Acute cerebrovascular disease |
| 110 | Occlusion of stenosis of precerebral arteries |
| 111 | Other and ill-defined cerebrovascular disease |
| 112 | Transient cerebral ischemia |
| 113 | Late effects of cerebrovascular disease |
| Trauma | 207 | Pathological fracture |
| 225 | Joint disorders and dislocations; trauma-related |
| 226 | Fracture of neck of femur (hip) |
| 227 | Spinal cord injury |
| 228 | Skull and face fractures |
| 229 | Fracture of upper limb |
| 230 | Fracture of lower limb |
| 231 | Other fractures |
| 232 | Sprains and strains |
| 233 | Intracranial injury |
| 234 | Crushing injury or internal injury |
| 235 | Open wounds of head; neck; and trunk |
| 236 | Open wounds of extremities |
| 239 | Superficial injury; contusion |
| 244 | Other injuries and conditions due to external causes |
| 260 | All (external causes of injury and poisoning) |
| Endocrine/metabolic | 48 | Thyroid disorders |
| 49 | Diabetes mellitus without complication |
| 50 | Diabetes mellitus with complication |
| 51 | Other endocrine disorders |
| 53 | Disorders of lipid metabolism |
| 58 | Other nutritional and endocrine/metabolic disorders |
| 186 | Diabetes or abnormal glucose tolerance complicating pregnancy; childbirth; or the puerperium |
| Neuropsychiatric | 650 | Adjustment disorders |
| 651 | Anxiety disorders |
| 652 | Attention-deficit, conduct, and disruptive behavior disorders |
| 653 | Delirium, dementia, and amnestic and other cognitive disorders |
| 654 | Developmental disorders |
| 655 | Disorders usually diagnosed in infancy and childhood or adolescence |
| 656 | Impulse control disorders, NEC |
| 657 | Mood disorders |
| 658 | Personality disorders |
| 659 | Schizophrenia and other psychotic disorders |
| 660 | Alcohol-related disorders |
| 661 | Substance-related disorders |
| 662 | Suicide and intentional self-inflicted injury |
| 663 | Screening and history of mental health and substance abuse codes |
| 670 | Miscellaneous mental health disorders |
| 79 | Parkinson's disease |
| 80 | Multiple sclerosis |
| 81 | Other hereditary and degenerative nervous system conditions |
| 82 | Paralysis |
| 83 | Epilepsy, convulsions |
| 84 | Headache including migraine |
| 85 | Coma, stupor and brain damage |
| 95 | Other nervous system disorders |
| 216 | Nervous system congenital anomalies |
| 650 | Adjustment disorders |
| 651 | Anxiety disorders |
| 652 | Attention-deficit, conduct, and disruptive behavior disorders |
| 653 | Delirium, dementia, and amnestic and other cognitive disorders |
| 654 | Developmental disorders |
| 655 | Disorders usually diagnosed in infancy and childhood or adolescence |
| 656 | Impulse control disorders |
| 657 | Mood disorders |
| 658 | Personality disorders |
| 659 | Schizophrenia and other psychotic disorders |
| 660 | Alcohol-related disorders |
| 661 | Substance-related disorders |
| 662 | Suicide and intentional self-inflicted injury |
| 663 | Screening and history of mental health and substance abuse codes |
| 670 | Miscellaneous mental health disorders |
| Hematological/neoplastic | 11 | Cancer of head and neck |
| 12 | Cancer of esophagus |
| 13 | Cancer of stomach |
| 14 | Cancer of colon |
| 15 | Cancer of rectum and anus |
| 16 | Cancer of liver and intrahepatic bile ducts |
| 17 | Cancer of pancreas |
| 18 | Cancer of other gastrointestinal organs, peritoneum |
| 19 | Cancer of bronchus, lung |
| 20 | Cancer of other respiratory and intrathoracic |
| 21 | Cancer of bone and connective tissue |
| 22 | Melanoma of skin |
| 23 | Other non-epithelial cancer of skin |
| 24 | Cancer of breast |
| 25 | Cancer of uterus |
| 26 | Cancer of cervix |
| 27 | Cancer of ovary |
| 28 | Cancer of other female genital organs |
| 29 | Cancer of prostate |
| 30 | Cancer of testis |
| 31 | Cancer of other male genital organs |
| 32 | Cancer of bladder |
| 33 | Cancer of kidney and renal pelvis |
| 34 | Cancer of other urinary organs |
| 35 | Cancer of brain and nervous system |
| 36 | Cancer of thyroid |
| 37 | Hodgkin's disease |
| 38 | Non-Hodgkin's lymphoma |
| 39 | Leukemias |
| 40 | Multiple myeloma |
| 41 | Cancer, other and unspecified primary |
| 42 | Secondary malignancies |
| 43 | Malignant neoplasm without specification of site |
| 44 | Neoplasm of unspecified nature or uncertain behavior |
| 46 | Benign neoplasm of uterus |
| 47 | Other and unspecified benign neoplasm |
| 59 | Deficiency and other anemias |
| 61 | Sickle cell anemia |
| 62 | Coagulation and hemorrhagic disorders |
| 63 | Disease of white blood cells |
| 64 | Other hematologic conditions |
| Rheumatology problem | 54 | Gout and other crystal arthropathies |
| Opthalmology problem | 86 | Cataract |
| 87 | Retinal detachment defects, vascular occlusion and retinopathy |
| 88 | Glaucoma |
| 89 | Blindness and vision defects |
| 91 | Other eye disorders |
| ENT problem | 92 | Otitis media and related conditions |
| 93 | Conditions associate with dizziness or vertigo |
| 94 | Other ear and sense organ disorder |
| Non-specific chest pain | 102 | Non-specific chest pain |
| Oral health problem | 136 | Disorders of teeth and jaw |
| 137 | Diseases of mouth; excluding dental |
| Obstetric admission including pregnancy | 174 | Female infertility |
| 176 | Contraceptive and procreative management |
| 177 | Spontaneous abortion |
| 178 | Induced abortion |
| 179 | Postabortion complication |
| 180 | Ectopic pregnancy |
| 181 | Other complications of pregnancy |
| 184 | Early or threatened labor |
| 185 | Prolonged pregnancy |
| 187 | Malposition; malpresentation |
| 188 | Fetopelvic disproportion; obstruction |
| 189 | Previous C-section |
| 190 | Fetal distress and abnormal forces of labor |
| 191 | Polyhydramnios and other problems of amniotic cavity |
| 192 | Umbilical cord complication |
| 193 | OB-related trauma to perineum and vulva |
| 194 | Forceps delivery |
| 195 | Other complications of birth; puerperium affecting management of mother |
| 196 | Other pregnancy and deliver including normal |
| 218 | Liveborn |
| 219 | Short gestation; low birth weight; and fetal growth retardation |
| 220 | Intrauterine hypoxia and birth asphyxia |
| 223 | Birth trauma |
| 224 | Other perinatal conditions |
| Dermatology problem | 198 | Other inflammatory condition of skin |
| 199 | Chronic ulcer of skin |
| 200 | Other skin disorders |
| Poisoning | 241 | Poisoning by psychotrophic agents |
| 242 | Poisoning by other medication and drugs |
| 243 | Poisoning by nonmedical substances |
| Syncope | 245 | Syncope |
| Other non-cardiac | 10 | Immunization and screening for infectious disease |
| 45 | Maintenance chemotherapy, radiotherapy |
| 52 | Nutritional deficiencies |
| 55 | Fluid and electrolyte disorders |
| 56 | Cystic fibrosis |
| 57 | Immunity disorder |
| 120 | Hemorrhoids |
| 121 | Other diseases of veins and lymphatics |
| 167 | Nonmalignant breast conditions |
| 168 | Inflammatory disease of female pelvic organs |
| 169 | Endometriosis |
| 172 | Ovarian cyst |
| 173 | Menopausal disorders |
| 202 | Rheumatoid arthritis and related disease |
| 203 | Osteoarthritis |
| 204 | Other non-traumatic joint disorders |
| 205 | Spondylosis; intervertebral disc disorders; other back problems |
| 206 | Osteoporosis |
| 208 | Acquired foot deformities |
| 209 | Other acquired deformities |
| 210 | Systemic lupus erythematosus and connective tissue disorders |
| 211 | Other connective tissue disease |
| 212 | Other bone disease and musculoskeletal deformities |
| 217 | Other congenital anomalies |
| 237 | Complication of device; implant or graft |
| 238 | Complications of surgical procedure or medical care |
| 240 | Burns |
| 246 | Fever of unknown origin |
| 247 | Lymphadenitis |
| 248 | Gangrene |
| 252 | Malaise and fatigue |
| 253 | Allergic reactions |
| 254 | Rehabilitation care; fitting of prostheses; and adjustment of devices |
| 255 | Administrative/social admission |
| 256 | Medical examination/evaluation |
| 257 | Other aftercare |
| 258 | Other screening for suspected conditions (not mental disorders or infectious disease) |
| 259 | Residual codes; unclassified |
| Heart failure | 108 | Congestive heart failure non-hypertensive |
| Arrhythmia | 106 | Cardiac dysrhythmias |
| 107 | Cardiac arrest and ventricular fibrillation |
| Conduction disorder | 105 | Conduction disorders |
| Valve disorders | 96 | Heart valve disorder |
| Hyper/hypotension | 98 | Essential hypertension |
| 99 | Hypertension with complications and secondary hypertension |
| 183 | Hypertension complicating pregnancy; childbirth and the puerperium |
| 249 | Shock |
| Pericarditis | 97 | Peri-, endo- and myocarditis, cardiomyopathy |
| Coronary artery disease including angina | 101 | Coronary atherosclerosis and other heart disease includes angina |
| Acute myocardial infarction | 100 | Acute myocardial infarction |
| Others (cardiac) | 103 | Pulmonary heart disease |
| 104 | Other and ill-defined heart disease |
| 213 | Cardiac and circulatory congenital anomalies |

**Supplementary Table 2: Factors associated with 30-day unplanned readmissions after PCI to the index or non-index hospital.**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Variable | Index hospital | | | | Non-index hospital | | | |
|  | Odds ratio | 95%CI |  | p-value | Odds ratio | 95%CI |  | p-value |
| Age (per year) | 1.00 | 1.00 | 1.00 | 0.10 | 1.00 | 0.99 | 1.00 | 0.002 |
| Women | 1.23 | 1.20 | 1.26 | <0.001 | 1.21 | 1.16 | 1.26 | <0.001 |
| Year vs 2010 | |  |  |  |  |  |  |  |
| 2011 | 0.99 | 0.94 | 1.05 | 0.79 | 0.94 | 0.85 | 1.03 | 0.20 |
| 2012 | 0.93 | 0.89 | 0.98 | 0.012 | 0.88 | 0.80 | 0.98 | 0.014 |
| 2013 | 0.93 | 0.88 | 0.97 | 0.003 | 0.82 | 0.75 | 0.90 | <0.001 |
| 2014 | 0.87 | 0.82 | 0.92 | <0.001 | 0.76 | 0.69 | 0.83 | <0.001 |
| Elective index PCI | 0.57 | 0.55 | 0.59 | <0.001 | 0.92 | 0.87 | 0.98 | 0.014 |
| Weekend admission | 1.02 | 0.99 | 1.04 | 0.22 | 1.00 | 0.95 | 1.04 | 0.92 |
| Primary expected payer vs Medicare | | |  |  |  |  |  |  |
| Medicaid | 1.12 | 1.08 | 1.16 | <0.001 | 1.21 | 1.13 | 1.30 | <0.001 |
| Private | 0.70 | 0.68 | 0.72 | <0.001 | 0.63 | 0.59 | 0.66 | <0.001 |
| Uninsured | 0.72 | 0.68 | 0.76 | <0.001 | 0.80 | 0.73 | 0.88 | <0.001 |
| No charge | 0.89 | 0.79 | 1.00 | 0.049 | 0.79 | 0.63 | 0.98 | 0.034 |
| Other | 0.82 | 0.77 | 0.87 | <0.001 | 0.76 | 0.69 | 0.85 | <0.001 |
| Median household income based on ZIP code vs 0-25th percentile | | | | | |  |  |  |
| 26-50th percentile | 0.97 | 0.94 | 1.00 | 0.038 | 1.00 | 0.95 | 1.06 | 0.95 |
| 51-75th percentile | 0.96 | 0.93 | 0.99 | 0.014 | 0.98 | 0.92 | 1.05 | 0.60 |
| 76-100th percentile | 0.92 | 0.89 | 0.96 | <0.001 | 1.11 | 1.04 | 1.19 | 0.002 |
| Smoker | 0.94 | 0.92 | 0.96 | <0.001 | 1.00 | 0.96 | 1.04 | 0.97 |
| Alcohol misuse | 1.02 | 0.96 | 1.08 | 0.57 | 1.30 | 1.18 | 1.44 | <0.001 |
| Comorbidities | |  |  |  |  |  |  |  |
| Dyslipidemia | 0.88 | 0.86 | 0.90 | <0.001 | 0.88 | 0.85 | 0.92 | <0.001 |
| Hypertension | 1.06 | 1.04 | 1.09 | <0.001 | 1.11 | 1.06 | 1.16 | <0.001 |
| Diabetes mellitus | 1.20 | 1.18 | 1.23 | <0.001 | 1.26 | 1.21 | 1.31 | <0.001 |
| Obesity | 0.92 | 0.89 | 0.94 | <0.001 | 0.97 | 0.93 | 1.02 | 0.25 |
| Previous heart failure | 0.94 | 0.86 | 1.03 | 0.20 | 1.00 | 0.86 | 1.17 | 0.96 |
| Previous coronary artery disease | 0.98 | 0.94 | 1.02 | 0.33 | 1.22 | 1.11 | 1.33 | <0.001 |
| Previous myocardial infarction | 1.01 | 0.98 | 1.04 | 0.53 | 1.14 | 1.08 | 1.21 | <0.001 |
| Previous PCI | 1.00 | 0.98 | 1.03 | 0.89 | 1.03 | 0.99 | 1.08 | 0.17 |
| Previous CABG | 1.07 | 1.03 | 1.11 | 0.001 | 1.19 | 1.12 | 1.26 | <0.001 |
| Previous heart valve disease | 1.10 | 0.93 | 1.29 | 0.26 | 1.10 | 0.84 | 1.43 | 0.50 |
| Atrial fibrillation | 1.39 | 1.35 | 1.43 | <0.001 | 1.43 | 1.36 | 1.51 | <0.001 |
| Previous stroke/TIA | 1.13 | 1.10 | 1.18 | <0.001 | 1.29 | 1.21 | 1.38 | <0.001 |
| Peripheral vascular disease | 1.16 | 1.12 | 1.19 | <0.001 | 1.25 | 1.19 | 1.32 | <0.001 |
| Pulmonary circulatory disorder | 1.04 | 0.86 | 1.25 | 0.72 | 0.88 | 0.15 | 1.22 | 0.45 |
| Peptic ulcer disease | 0.44 | 0.22 | 0.90 | 0.024 | 1.02 | 0.50 | 2.11 | 0.95 |
| Chronic lung disease | 1.35 | 1.31 | 1.38 | <0.001 | 1.48 | 1.42 | 1.55 | <0.001 |
| Renal failure | 1.43 | 1.38 | 1.47 | <0.001 | 1.52 | 1.44 | 1.60 | <0.001 |
| Liver disease | 1.38 | 1.28 | 1.49 | <0.001 | 1.35 | 1.19 | 1.53 | <0.001 |
| Hypothyroidism | 1.03 | 0.99 | 1.06 | 0.12 | 1.02 | 0.96 | 1.08 | 0.52 |
| Fluid and electrolyte disorder | 1.20 | 1.16 | 1.24 | <0.001 | 1.19 | 1.13 | 1.25 | <0.001 |
| Anemia | 1.26 | 1.22 | 1.30 | <0.001 | 1.45 | 1.38 | 1.53 | <0.001 |
| Cancer | 1.35 | 1.26 | 1.45 | <0.001 | 1.46 | 1.30 | 1.62 | <0.001 |
| Depression | 1.23 | 1.19 | 1.28 | <0.001 | 1.21 | 1.14 | 1.28 | <0.001 |
| Dementia | 1.10 | 1.02 | 1.18 | <0.001 | 1.38 | 1.23 | 1.55 | <0.001 |
| Hospital variables | |  |  |  |  |  |  |  |
| Size based on number of beds vs small | | | |  |  |  |  |  |
| Medium | 1.10 | 1.00 | 1.21 | 0.047 | 0.80 | 0.70 | 0.90 | <0.001 |
| Large | 1.12 | 1.02 | 1.23 | 0.019 | 0.77 | 0.68 | 0.86 | <0.001 |
| Urban classification | 1.22 | 0.90 | 1.65 | 0.21 | 1.11 | 0.74 | 1.66 | 0.63 |
| Teaching hospital | 0.96 | 0.93 | 0.99 | 0.007 | 1.10 | 1.04 | 1.17 | 0.002 |
| Procedural details | |  |  |  |  |  |  |  |
| Multivessel disease | 1.03 | 1.00 | 1.06 | 0.022 | 0.96 | 0.92 | 1.01 | 0.14 |
| Bifurcation disease | 0.93 | 0.87 | 0.99 | 0.026 | 1.01 | 0.90 | 1.13 | 0.88 |
| Use of circulatory support | 1.14 | 0.97 | 1.34 | 0.10 | 1.16 | 0.88 | 1.53 | 0.28 |
| Use of vasopressor | 1.06 | 0.90 | 1.24 | 0.51 | 0.80 | 0.60 | 1.06 | 0.12 |
| Use of intra-aortic balloon pump | 1.16 | 0.98 | 1.38 | 0.083 | 1.15 | 0.85 | 1.54 | 0.37 |
| Use of fractional flow reserve | 1.14 | 1.06 | 1.22 | <0.001 | 1.22 | 1.08 | 1.38 | 0.002 |
| Use of intravascular ultrasound | 1.02 | 0.98 | 1.06 | 0.41 | 1.06 | 0.98 | 1.14 | 0.14 |
| Use of drug eluting stent | 0.87 | 0.85 | 0.89 | <0.001 | 0.81 | 0.78 | 0.84 | <0.001 |
| Periprocedural events | |  |  |  |  |  |  |  |
| Complete heart block | 0.94 | 0.84 | 1.04 | 0.21 | 1.00 | 0.84 | 1.18 | 0.96 |
| Stroke/TIA | 0.96 | 0.91 | 1.02 | 0.22 | 1.05 | 0.95 | 1.15 | 0.32 |
| Cardiogenic shock | 1.01 | 0.95 | 1.09 | 0.69 | 1.20 | 1.06 | 1.36 | 0.004 |
| Cardiac arrest | 0.95 | 0.88 | 1.03 | 0.23 | 0.90 | 0.78 | 1.03 | 0.13 |
| Acute kidney injury | 1.09 | 1.05 | 1.13 | <0.001 | 1.10 | 1.02 | 1.18 | 0.013 |
| Major bleeding | 1.18 | 1.04 | 1.33 | 0.010 | 1.06 | 0.88 | 1.28 | 0.53 |
| Blood transfusion | 1.34 | 0.95 | 1.90 | 0.094 | 0.74 | 0.33 | 1.66 | 0.47 |
| Vascular complication | 1.18 | 1.06 | 1.31 | 0.002 | 1.10 | 0.94 | 1.30 | 0.23 |
| Coronary artery bypass graft | 0.83 | 0.76 | 0.92 | <0.001 | 0.61 | 0.50 | 0.75 | <0.001 |
| Length of stay (per day) | 0.99 | 0.99 | 0.99 | <0.001 | 1.00 | 0.99 | 1.00 | 0.039 |
| Discharge location vs home or self-care | | | |  |  |  |  |  |
| Nursing facility | 1.45 | 1.40 | 1.50 | <0.001 | 1.36 | 1.28 | 1.45 | <0.001 |
| Discharge against medical advice | 1.58 | 1.40 | 1.78 | <0.001 | 3.21 | 2.77 | 3.72 | <0.001 |

CABG = coronary artery bypass graft, PCI = percutaneous coronary intervention, TIA = transient ischemic attack

**Supplementary Table 3: Impact of adjustments for readmission hospital that had PCI facilities on odds of adverse outcomes for readmission to non-index compared to index hospital**

|  |  |  |
| --- | --- | --- |
| Outcome during readmission | Odds ratio (95%CI) for admission to non-index vs index hospital† | Odds ratio (95%CI) for admission to non-index vs index hospital‡ |
| Acute myocardial infarction | 0.88 (0.82-0.95) | 1.08 (1.00-1.17) |
| PCI | 0.44 (0.41-0.49) | 0.65 (0.59-0.71) |
| Death | 1.30 (1.14-1.48) | 1.62 (1.40-1.86) |
| Composite of acute myocardial infarction, PCI, death | 0.61 (0.57-0.65) | 0.82 (0.76-0.88) |

†Adjusted for all variables in Table 1.

‡Adjusted for all variables in Table 1 and whether readmission hospital had PCI facilities.

**Supplementary Figure 1: Flow diagram of patient inclusion.**



**Supplementary Figure 2: Rate of readmissions to different and same hospital between 2010 and 2014.**

****