**Relation of Length of Stay to Unplanned Readmissions For Patients Who Undergo Elective Percutaneous Coronary Intervention**

Running title: Length of stay and readmission in elective PCI

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**Abstract**

The cost of inpatient PCI procedure is related to LOS. It is unknown how LOS may be associated with readmission rates and costs of index PCI and readmissions in elective PCI. This study aims to evaluate rates, predictors, causes and costs associated with 30-day unplanned readmissions according to length of stay (LOS) in patients who undergo elective percutaneous coronary interventions (PCI).We included patients in the Nationwide Readmission Database who were admitted to hospital between 2010 and 2014 who underwent uncomplicated elective PCI. LOS was defined as 0, 1, 2 and ≥3 days. A total of 324,345 patients were included in the analysis and the 30-day unplanned readmission was 4.75%, 4.67%, 6.44% and 9.42% in the LOS groups 0, 1, 2 and ≥3 days, respectively. Prolonged LOS was associated with increased average total 30-day cost (index and readmission cost, 0 days $15,063, 1 day $14,693, 2 days $18,136 and ≥3 days $24,336). Compared to 0 days, the odds of readmissions were greater for 2 days (OR 1.41 95%CI 1.07-1.87, p=0.016) and ≥3 days (OR 1.70 95%CI 1.28-2.24, p<0.001). Comorbidities were strong predictors of LOS and non-cardiac causes account for more than half of all causes for readmission. Longer LOS was associated with reduced incidence of readmissions for non-cardiac causes such as non-cardiac chest pain but a greater rate of readmissions for heart failure.In conclusion, shorter length of stay was associated with reduced healthcare costs in elective PCI.

**Keywords:** percutaneous coronary intervention; readmissions; length of stay

**Introduction**

Percutaneous coronary intervention (PCI) is the most common form of coronary revascularization undertaken in the United States1 with in-hospital mortality rates less than 1%.3,4 Length of stay (LOS) in PCI is an area of interest because a significant proportional cost of the procedure is associated with LOS in hospital.5 To date, several studies have been conducted demonstrating the safety of same day discharge (SDD) in the elective setting6-9 The financial considerations of SDD and readmissions in PCI have previously been reported in the EASY trial of 1005 patients from a single Canadian center a decade ago,10,11 although index and readmission costs have not been evaluated from a national perspective previously. Previous studies of the cost implications of SDD in PCI from the National Cardiovascular Data Registry (NCDR) linked to Medicare only considered index hospital costs, and did not consider readmissions or the costs associated with readmissions.12

Early readmission rates, predictors of readmission and causes of readmission in the elective PCI patient group according to LOS has not been explored before at a national level, and in particular whether SDD is associated with increased 30 day unplanned readmissions, thereby offsetting the initial financial savings achieved during SDD. In this study, we aimed to examine: i) whether SDD and LOS were associated with increased 30-day unplanned readmission rates ii) the cost associated with SDD and total costs including first readmissions within 30 days and iii) predictors and causes of readmission after elective PCI stratified by LOS using the Nationwide Readmission Database (NRD), the largest all-payer database of hospital readmissions in the United States.

**Methods**

The NRD contains a nationally representative sample of all-age, all-payer discharges from US non-federal hospitals produced by the Healthcare Cost and Utilization Project (HCUP) of the Agency for Healthcare Research and Quality.13 This database is derived from discharge-level data from hospitalizations from 21 geographically-dispersed participating states which represents 49.3% of the total US population and 49.1% of all US hospitalizations.14 Readmissions are identified from the de-identified unique patient linkage number assigned to each patient, which allows tracking of patients across hospitals within a state during a calendar year. For the current study, unplanned readmissions were defined as any inpatient episode in a hospital within 30 days of discharge after an index elective hospitalization where a patient underwent PCI.

Each patient in the NRD dataset has up to 15 International Disease Classification (ICD)-9 procedural codes for each admission to hospital. Patients with PCI were determined from the procedural codes 0066 (PTCA OR CORONARY ATHER), 3606 (INSERT CORON ART STENT) and 3607 (INSERT DRUG ELUTING CRNRY AR).15 We excluded patients with an elective readmission (as staged PCI procedure are not considered unplanned readmissions), patients who died during the initial admission and those who were discharged in the month of December (these patients may not have had complete 30 day follow up). We applied further exclusions if patients had circulatory support or had an in-hospital complication such as complete heart block, stroke/transient ischemic attack, cardiogenic shock, acute kidney injury, major bleeding, vascular complication or emergency coronary artery bypass graft (CABG) because this may justify a prolonged hospital stay.

The primary outcome was the rate of unplanned readmission within 30 days of hospitalization with PCI. We included patients who underwent PCI with discharge dates in 2010 and 2014 with 30-day follow up. The cost of (i) index admission and (ii) readmissions (where relevant) for each patient was determined by multiplying the hospital charges with AHRQ’s all-payer cost-to-charge ratios for each hospital. The total cost was defined by index admission and cost of first readmission.

The ICD-9 codes were used to define clinical variables including smoking status, dyslipidemia, coronary artery disease, previous myocardial infarction, previous PCI, previous CABG, previous stroke or TIA, atrial fibrillation and dementia. The other comorbidity variables in the analysis were available via the Elixhauser comorbidities16 which 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 and anemia. The paralysis variable from the Elixhauser comorbidities was used as a surrogate for hemiplegia, and connective tissue disease and leukemia where defined by CCS codes 210, 211 & 39 respectively. Combining these variables enabled us to compute the Charlson comorbidity index.15 The number of comorbidities was the sum of the comorbidities 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, transient ischemia attack or stroke, cardiogenic shock, cardiac arrest, acute kidney injury, major bleeding, blood transfusion, vascular complication and emergency CABG. Additional data were collected on LOS in hospital, hospital bed size, hospital location and hospital teaching status and discharge destination. The causes of readmission 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 using Stata 14.0 (College Station, TX). We report the overall and LOS stratified crude rates of elective inpatient PCI procedures as defined by the elective variable by the HCUP. Descriptive statistics are presented according to LOS and readmission status or all included variables. The statistical differences between readmitted and non-readmitted patients for continuous and categorical variables were compared using the t-test and Chi2 test, respectively. Multiple logistic regressions were used to determine the independent predictors of each LOS group. A second multiple logistic regression was used to determine the odds of 30-day unplanned readmissions according to LOS group 1, 2 and ≥3 days compared to SDD. Candidate variables to be adjusted for in logistic regression models were age, sex, year, elective admission, weekend admission, diagnosis of acute myocardial infarction, 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 coronary artery bypass graft (CABG), previous valve disease, atrial fibrillation, previous TIA/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, multivessel disease, bifurcation lesion, fractional flow reserve, intravascular ultrasound use, and drug eluting stent. The mean cost of index admission for PCI and the costs associated with readmissions were computed and are shown graphically. The causes of readmission within 30 days are presented in figure and table format as (a) non-cardiac and (b) cardiac.

**Results**

A total of 324,345 patients were included in the analysis (Supplementary Figure 1). Unplanned readmissions occurred in 5.8% (n=18,781) participants. We observed an increase over 2010 to 2014 in same day discharge rate that was statistically significant (p-trend <0.001) (Figure 1). The proportion of cases in which the LOS was 1 day decreased over time from 68.7% to 46.6% whilst the proportion of cases that had 2 or ≥3 days admissions increased from 15.6% to 25.8% and 14.7% to 25.9% respectively. The 30-day unplanned readmission rates were 4.75%, 4.67%, 6.44% and 9.42% in the LOS groups 0, 1, 2 and ≥3 days, respectively (Figure 2).

The patient and institutional characteristics according to LOS are shown in Table 1. Patients with SDD were older (68.2 years compared to 66.8 years in 1 day, 65.3 years in 2 days and 66.2 years in ≥3 days, p<0.001) and were more likely to receive Medicare (75.7% compared to 61.6% in 1 day, 56.5% in 2 days and 60.2% in ≥3 days, p<0.001), whilst patients who had private healthcare had the lowest SDD rates (17.6% compared to 29.2% for 1 day, 30.7% for 2 days and 25.6% for ≥3 days, p<0.001). Patients with the longest LOS (≥3 days LOS) had the highest comorbidities and worse risk factor profile, as evidenced by the highest proportion of smokers (36.5%), obesity (16.4%), diabetes (40.7%), atrial fibrillation (15.7%), peripheral vascular disease (15.5%), chronic lung disease (19.4%), renal failure (20.6%), and anemia (14.6%) (all had p<0.001). Patients with SDD had the highest percentage of patients with previous myocardial infarction (16.1%), previous PCI (26.1%) and previous CABG (12.6%). The cost of index admission was $14,516 for 0 days, $14,190 for 1 day, $17,444 for 2 days and $23,189 for ≥3 days.

The patient characteristics according to LOS and readmission status are shown in Table 2. In all LOS groups, patients who were female were more likely to be readmitted (p<0.001). Patients who had private healthcare also had lower rates of readmission in all LOS groups (10.8% vs 18.0% in 0 days, 21.0% vs 29.6% in 1 day, 21.7% vs 31.3% in 2 days and 17.3% vs 26.5% in ≥3 days). Patients who experienced an unplanned 30-day readmission had a greater prevalence of individual comorbid conditions and global comorbid burden. For example, there were more patients with diabetes, atrial fibrillation, peripheral vascular disease, chronic lung disease, renal failure, fluid and electrolyte disorders and anemia readmitted across all LOS groups. Similarly, readmitted patients had higher Charlson Comorbidity Index compared across all LOS categories (1.6 vs 1.1 in 0 days, p<0.001, 1.4 vs 1.0 in 1 day, p<0.001, 1.5 vs 1.1 in 2 days, p<0.001 and 5.6 vs 1.5 in ≥3 days group, p<0.001). The cost associated with the readmission was not significantly different when day 1, 2 and ≥3 days were compared to 0 days ($10,916, $10,817 and $12,328 for 1, 2 and ≥3 days vs $11,504 for 0 days, p=0.072, 0.61 and 0.66 respectively). The average treatment cost for 30-days (average cost of index admission and readmissions within 30 days when they occur) for the LOS 0 days was $15,063 which was significantly greater than LOS 1 day ($14,963, p=0.032) but significantly less than 2 days ($18,136, p<0.001) and 3 days ($24,336, p<0.001).

Compared to SDD (LOS=0 days) the odds of readmission for 1 day LOS was not statistically different (OR 1.01 95%CI 0.77-1.32, p=0.96) but there was a significant increase for 2 days (OR 1.41 95%CI 1.07-1.87, p=0.016) and ≥3 days (OR 1.70 95%CI 1.28-2.24, p<0.001) (Figure 3).

The independent predictors of readmissions within LOS groups are shown in Supplementary Table 2. Patients discharged on the same day were more likely to be readmitted if they had atrial fibrillation (OR 2.58 95%CI 1.23-5.43, p=0.012), previous transient ischemic attack or stroke (OR 3.39 95%CI 1.71-6.72, p=0.001) and fluid and electrolyte disorders (OR 6.11 95%CI 1.63-22.89, p=0.007).

The causes of readmission are shown in Figure 5 and Table 3. Longer LOS was associated with reduced incidence of readmissions for non-cardiac causes (LOS 0 days 60.8%, 1 day 62.8%, 2 days 57.9%, ≥3 days 58.2%). A decline in non-specific chest pain as a cause for readmission was observed with prolonged hospital stay (LOS 0 days 12.7%, 1 day 10.8%, 2 days 10.9% and ≥3 days 7.5%). SDD had the highest rate of readmission for angina and atherosclerotic heart disease (17.6%) and acute myocardial infarction (9.8%). Prolonged LOS in hospital was associated with higher rates of readmission for heart failure (LOS 0 days 3.9%, 1 day 4.6%, 2 days 7.8% and ≥3 days 10.7%).

**Discussion**

Our study provides several important findings. First, we observed that longer hospital stay is associated with a graded increase in the rate of unplanned readmission according to index LOS in elective PCI. Unlike previous studies which focus on LOS as a binary categorical variable (SDD and non-SDD), our results provide further granularity through consideration of length of stay in a graded manner. Secondly, the cost saved associated with reduced hospital stay persists at 30 days, with cost savings associated with SDD / shorter lengths of stay not offset by increased healthcare costs of readmission. Thirdly, irrespective of LOS, readmission risk is most influenced by age, female sex and comorbidities. Finally, the patterns and causes of readmissions depend on the LOS, that most likely relate to the differences in the risk profile of patients in each LOS group.

The major clinical implication of the current study is that there does not appear to be increased risk of readmissions with SDD and shorter LOS (SDD and overnight stay) in elective PCI. Previous studies have not studied the influence of LOS by considering 0, 1, 2 and ≥3 days which incur different costs at index admission and these studies have not considered the cost of index PCI admission as well as the first unplanned readmission. This is important as total healthcare costs extend beyond direct causes of an index admission but also the cost of the readmissions. Interestingly, whilst we observed that the total 30-day cost for SDD was slightly greater than for patients with an overnight stay, this was driven by the greater costs associated with the SDD index admission, as these patients were older and more comorbid than those admitted for overnight stay. Nevertheless, savings associated with shorter LOS are not offset by greater healthcare costs at 30 days due to increased readmissions in these groups.

SDD and 30-day rehospitalizations after PCI has been explored in the Early Discharge After Transradial Stenting of Coronary Arteries (EASY) study.10 Repeat hospitalization and unsolicited medical visits in this study occurred in 4.1% and 6.2%, respectively among SDD patients. The financial implications of SDD was explored in a follow up analysis suggest that SDD is associated with a 50% reduction in medical costs over 30 days, with no late catch up phenomenon exhibited in that study either, so for every 1,000 patients there could be $1 million in savings.11 We have extended the financial considerations applying it to a national setting and considered the cost in different length of stay groups. These findings, together with those of the current study suggest that SDD is not associated with increased resource utilization or cost during the 30-day follow-up period.

Our study shows that longer lengths of stay (> 1 day) were associated with increased odds of readmission. There are several explanations for this; firstly, we observed that patients with longer hospital stay are more likely to have significant comorbidities that are known to be independent predictors of readmissions.15 Whilst, we attempted to adjust for differences in comorbid condition prevalence amongst the different LOS groups, our dataset does not capture the severity of each individual comorbidity. We also observed a decline in non-cardiac readmissions with increasing LOS and one possible reason for this is that the longer admission results in better management of comorbidities so there are fewer non-cardiac readmissions but this requires further investigation. Secondly, while we were able to exclude a variety of factors associated with higher risk of adverse outcomes such as use of circulatory support, cardiogenic shock and in-hospital complications, there may still be unmeasured factors that warrant admission for observation such as patient frailty.17

It has also been reported that post-procedural complications were the strongest predictor of prolonged observation in a study of 1015 patients who underwent elective PCI.18 In the current study, we excluded patients that had sustained PCI complications in their index event because such patients by necessity would need to remain as inpatients for longer periods of time and would confound our results towards worse outcomes for the longer LOS groups. Important determinants of LOS in the current low risk elective cohort appeared to be comorbidities such as atrial fibrillation, diabetes, renal failure and fluid and electrolyte disorders. Procedural variables such as access site, lesion complexity, contrast exposure, angiographic results and method of hemostasis are not captured by this dataset and so cannot be included in our analyses.

We found that non-cardiac readmissions are common after PCI. One reason for this may be related to inadequate management of pre-existing non-cardiac comorbidities. We observed a greater prevalence of diabetes, chronic lung disease, renal failure, anemia and cancer comparing patients who were readmitted to those who were not readmitted. It is not clear whether any additional routine or specialist management of these non-cardiac existing conditions took place during the index admission for PCI or plans for these conditions to be managed as an outpatient. Another contribution to non-cardiac readmissions may be complications of the cardiac procedure. Antiplatelet therapy may cause bleeding and aspirin may exacerbate symptoms of dyspepsia. Contrast exposure may result in renal failure and patients who undergo procedures in hospitals may be at risk of hospital acquired infections. Finally, the most frequent cause of readmission was chest pain and patients who had a stent may have a lower threshold of returning to hospital because they are concerned about a recurrence of coronary disease.

A key limitation of the current study is that it likely under report day-case or same-day admission for PCI. SDD has been reported to be 0.9% in an analysis of uncomplicated elective PCI in the Nationwide Inpatient Sample19 and the NRD is provided by the same data source. Data from Medicare in 2004 to 2008 has been linked to the more complete PCI records of the CathPCI registry in the United States but rates of SDD discharge are also low at 1.25%.20 Low rates of SDD may reflect the increasing shift from inpatient to non admission PCI procedures which would serve to under-estimate the proportion of patients undergoing SDD PCI.21 Secondly, the elective procedures captured in the current dataset may not be representative of the totality of elective procedures in the United States, although over 300,000 PCI procedures were included in this analysis that provides significant statistical power to explore the relationships that we have studied. Thirdly, we do not know the date of the PCI during the admission, and so 30-day readmission rates were calculated from the date of discharge rather than the date of the PCI procedure. This may over-estimate 30-day readmission rates, although the average length of stay was short in the elective cohort (2 days) so even if we considered the date of admission as index PCI date, 30-day readmission rates only minimally decreased from 5.8% to 5.4% and there were no major changes in the rate of length of stay or healthcare costs. Also, the current dataset lacks information about operator or center practice which may be a major determinant for LOS during the index PCI procedure. Furthermore, there is no possible linkage between years as the data is derived from five unique datasets corresponding to each year between 2010 and 2014. Finally, studies of readmissions may be affected by bias related to survivorship in that patients who died following hospital discharge are not captured in the present analysis.

In the increasing cost-conscious and evidence based healthcare system, results from the current analysis suggest that SDD and shorter lengths of stay in elective patients are not associated with increased rates of unplanned readmission and that the savings achieved with shorter LOS are not offset by increased total healthcare cost at 30-days driven by unplanned readmissions. Longer LOS was associated with reduced incidence of readmissions for non-cardiac causes such as non-cardiac chest pain but a greater rate of readmissions for heart failure.

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**Supplementary Table 1:** Classification of CCS codes for readmissions causes

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**Table 1:** Patient characteristic according to length of stay

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Variable | 0 days (n=5,076) | 1 day (n=207,391) | | 2 days (n=56,832) | | ≥3 days (n=55,046) | |
| Mean±SD/% | Mean±SD/% | p-value | Mean±SD/% | p-value | Mean±SD/% | p-value |
| Age (year) | 68.2±10.5 | 66.8±10.7 | <0.001 | 65.3±11.8 | <0.001 | 66.2±11.9 | <0.001 |
| Women | 31.2% | 30.4% | 0.39 | 32.8% | 0.14 | 35.31% | <0.001 |
| Year |  |  | <0.001 |  | <0.001 |  | <0.001 |
| 2010 | 1.0% | 68.7% |  | 15.6% |  | 14.7% |  |
| 2011 | 1.6% | 66.4% |  | 16.2% |  | 15.8% |  |
| 2012 | 1.7% | 65.3% |  | 16.9% |  | 16.1% |  |
| 2013 | 2.2% | 62.7% |  | 17.6% |  | 17.4% |  |
| 2014 | 1.7% | 46.6% |  | 25.8% |  | 25.9% |  |
| Weekend | 10.6% | 1.4% | <0.001 | 9.0% | 0.012 | 13.8% | <0.001 |
| Primary expected payer |  |  | <0.001 |  | <0.001 |  | <0.001 |
| Medicare | 75.7% | 61.6% |  | 56.5% |  | 60.2% |  |
| Medicaid | 3.8% | 5.7% |  | 5.7% |  | 6.3% |  |
| Private | 17.6% | 29.2% |  | 30.7% |  | 25.6% |  |
| Uninsured | 1.4% | 1.3% |  | 3.8% |  | 4.1% |  |
| No charge | 0.1% | 0.2% |  | 0.4% |  | 0.5% |  |
| Other | 1.4% | 2.1% |  | 3.0% |  | 3.2% |  |
| Median household income (percentile) |  |  | <0.001 |  | 0.93 |  | <0.001 |
| 0-25th | 33.7% | 28.3% |  | 34.3% |  | 38.3% |  |
| 26-50th | 25.4% | 24.3% |  | 25.2% |  | 25.2% |  |
| 51-75th | 23.6% | 24.4% |  | 23.5% |  | 21.7% |  |
| 76-100th | 17.4% | 23.0% |  | 17.0% |  | 14.8% |  |
| Smoker | 30.8% | 30.9% | 0.96 | 36.2% | <0.001 | 36.5% | <0.001 |
| Alcohol misuse | 1.1% | 0.7% | 0.054 | 1.4% | 0.28 | 2.1% | 0.002 |
| Dyslipidemia (ICD-9 272.0-272.4) | 74.1% | 76.7% | 0.006 | 74.1% | 0.98 | 70.6% | <0.001 |
| Hypertension | 75.0% | 76.5% | 0.11 | 74.5% | 0.59 | 75.1% | 0.87 |
| Diabetes mellitus | 35.9% | 37.3% | 0.17 | 36.2% | 0.79 | 40.7% | <0.001 |
| Obesity (defined by AHRQ comorbidity measure) | 12.7% | 12.4% | 0.63 | 13.9% | 0.12 | 16.4% | <0.001 |
| Heart failure | 0.2% | 0.1% | <0.001 | 0.2% | 0.74 | 2.0% | <0.001 |
| Known coronary artery disease | 98.6% | 98.6% | 0.96 | 96.6% | <0.001 | 95.3% | <0.001 |
| Previous myocardial infarction | 16.1% | 14.9% | 0.13 | 12.6% | <0.001 | 13.4% | <0.001 |
| Previous percutaneous coronary intervention | 26.1% | 24.1% | 0.04 | 19.7% | <0.001 | 18.9% | <0.001 |
| Previous coronary artery bypass graft | 12.6% | 10.0% | <0.001 | 8.6% | <0.001 | 9.4% | <0.001 |
| Previous valve disease | 0.09% | 0.04% | 0.21 | 0.09% | 0.93 | 0.78% | <0.001 |
| Atrial fibrillation | 9.3% | 8.3% | 0.11 | 9.6% | 0.64 | 15.7% | <0.001 |
| Previous transient ischemic attack/stroke | 5.6% | 5.3% | 0.54 | 5.8% | 0.71 | 7.0% | 0.015 |
| Peripheral vascular disease | 11.7% | 11.3% | 0.65 | 12.1% | 0.53 | 15.5% | <0.001 |
| Pulmonary circulatory disorder | 0.05% | 0.02% | 0.38 | 0.03% | 0.75 | 0.4% | 0.009 |
| Peptic ulcer disease | 0.05% | 0.02% | 0.28 | 0.02% | 0.34 | 0.03% | 0.68 |
| Chronic lung disease | 13.0% | 11.8% | 0.10 | 13.9% | 0.25 | 19.4% | <0.001 |
| Renal failure | 11.1% | 9.5% | 0.014 | 12.2% | 0.15 | 20.6% | <0.001 |
| Liver disease | 1.0% | 0.7% | 0.12 | 0.9% | 0.60 | 1.7% | 0.022 |
| Hypothyroidism | 7.1% | 7.3% | 0.76 | 8.0% | 0.15 | 10.0% | <0.001 |
| Fluid and electrolyte disorders | 2.7% | 1.8% | 0.003 | 5.1% | <0.001 | 12.8% | <0.001 |
| Anemia | 5.7% | 4.1% | <0.001 | 6.3% | 0.23 | 14.6% | <0.001 |
| Cancer | 1.5% | 1.3% | 0.30 | 1.4% | 0.56 | 2.2% | 0.035 |
| Depression | 4.1% | 3.7% | 0.39 | 5.0% | 0.044 | 6.3% | <0.001 |
| Dementia | 0.4% | 0.5% | 0.30 | 0.9% | 0.011 | 1.4% | <0.001 |
| Charlson comorbidity index | 1.1±1.2 | 1.1±1.2 | 0.033 | 1.1±1.3 | 0.57 | 1.5±1.5 | <0.001 |
| Mean number of comorbidities | 4.6±1.9 | 4.5±1.8 | 0.019 | 4.6±1.8 | 0.64 | 5.1±2.1 | <0.001 |
| Bed size |  |  | <0.001 |  | <0.001 |  | <0.001 |
| Small | 9.5% | 9.6% |  | 6.9% |  | 5.5% |  |
| Medium | 21.3% | 17.6% |  | 21.9% |  | 20.2% |  |
| Large | 69.2% | 72.9% |  | 71.2% |  | 74.3% |  |
| Location |  |  | 0.35 |  | 0.084 |  | 0.056 |
| Rural | 0.1% | 0.2% |  | 0.3% |  | 0.3% |  |
| Urban | 99.9% | 99.8% |  | 99.7% |  | 99.7% |  |
| Teaching status |  |  | <0.001 |  | 0.15 |  | 0.050 |
| Nonteaching | 49.0% | 42.1% |  | 47.3% |  | 46.8% |  |
| Teaching status | 51.0% | 57.9% |  | 52.7% |  | 53.2% |  |
| Multivessel disease | 20.6% | 20.5% | 0.99 | 19.5% | 0.24 | 19.2% | 0.13 |
| Bifurcation | 3.8% | 4.2% | 0.42 | 3.2% | 0.13 | 2.8% | 0.009 |
| Fractional flow reserve | 4.5% | 2.9% | <0.001 | 2.2% | <0.001 | 2.3% | <0.001 |
| Intravascular ultrasound | 8.1% | 9.2% | 0.083 | 8.2% | 0.85 | 8.1% | 0.90 |
| Drug eluting stent | 80.4% | 82.5% | 0.009 | 78.2% | 0.017 | 72.3% | <0.001 |
| Cost of first admission (all patients) | $14,516±7,250 | $14,190±6,537 | 0.024 | $17,444±7,965 | <0.001 | $23,189±14,047 | <0.001 |
| Readmission at 30-days | 4.8% | 4.7% | 0.86 | 6.4% | 0.002 | 9.4% | <0.001 |
| Cost of readmission (readmitted only) | $11,504±11,789 | $10,916±16,279 | 0.072 | $10,817±13,041 | 0.61 | $12,328±18,548 | 0.66 |
| Cost of first admission and readmission (all patients) | $15,063±8,240 | $14,693±7,835 | 0.032 | $18,136±9,089 | <0.001 | $24,336±15,835 | <0.001 |
| Cost of first admission and readmission (readmitted only) | $27,617±16,650 | $24,974±18,186 | 0.15 | $27,878±15,894 | 0.87 | $36,425±24,662 | <0.001 |

ICD-9=International Classification of Disease, Ninth Revision, AHRQ=Agency for Healthcare Research and Quality

**Table 2:** Patient characteristic according to length of stay group and readmission status

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Variable | 0 days (n=5,076) | | | 1 day (n=207,391) | | | 2 days (n=56,832) | | | ≥3 days (n=55,046) | | |
| Not readmitted | Readmitted | p-value | Not readmitted | Readmitted | p-value | Not readmitted | Readmitted | p-value | Not readmitted | Readmitted | p-value |
| Age (year) | 68.2±10.4 | 67.4±11.6 | 0.42 | 66.8±10.7 | 68.1±11.4 | <0.001 | 65.2±11.8 | 67.1±12.3 | <0.001 | 66.0±11.9 | 67.8±11.9 | <0.001 |
| Women | 30.8% | 40.2% | 0.045 | 30.0% | 37.4% | <0.001 | 32.2% | 41.3% | <0.001 | 34.7% | 40.8% | <0.001 |
| Year |  |  | 0.53 |  |  | 0.47 |  |  | 0.33 |  |  | 0.82 |
| 2010 | 95.8% | 4.2% |  | 95.2% | 4.8% |  | 93.1% | 6.9% |  | 91.0% | 9.0% |  |
| 2011 | 95.2% | 4.8% |  | 95.4% | 4.7% |  | 93.9% | 6.2% |  | 90.5% | 9.5% |  |
| 2012 | 94.3% | 5.7% |  | 95.3% | 4.7% |  | 93.5% | 6.5% |  | 90.6% | 9.4% |  |
| 2013 | 94.3% | 5.1% |  | 95.3% | 4.7% |  | 93.5% | 6.5% |  | 90.3% | 9.7% |  |
| 2014 | 97.0% | 3.0% |  | 95.7% | 4.3% |  | 94.0% | 6.0% |  | 90.5% | 9.5% |  |
| Weekend | 10.5% | 11.8% | 0.69 | 1.4% | 1.7% | 0.14 | 9.1% | 7.0% | 0.005 | 14.0% | 12.1% | 0.014 |
| Primary expected payer |  |  | 0.16 |  |  | <0.001 |  |  | <0.001 |  |  | <0.001 |
| Medicare | 75.6% | 77.5% |  | 61.2% | 69.6% |  | 55.8% | 66.7% |  | 59.2% | 69.5% |  |
| Medicaid | 3.7% | 5.9% |  | 5.6% | 6.6% |  | 5.6% | 6.5% |  | 6.2% | 7.3% |  |
| Private | 18.0% | 10.8% |  | 29.6% | 21.0% |  | 31.3% | 21.7% |  | 26.5% | 17.3% |  |
| Uninsured | 1.3% | 2.9% |  | 1.3% | 1.0% |  | 3.9% | 2.3% |  | 4.2% | 3.0% |  |
| No charge | 0.1% | 0% |  | 0.2% | 0.2% |  | 0.4% | 0.5% |  | 0.5% | 0.4% |  |
| Other | 1.3% | 2.9% |  | 2.1% | 1.6% |  | 3.1% | 2.3% |  | 3.3% | 2.5% |  |
| Median household income (percentile) |  |  | 0.57 |  |  | 0.010 |  |  | 0.40 |  |  | 0.32 |
| 0-25th | 33.5% | 36.4% |  | 28.2% | 30.3% |  | 34.3% | 35.1% |  | 38.3% | 37.5% |  |
| 26-50th | 25.7% | 20.2% |  | 24.3% | 23.8% |  | 25.2% | 26.2% |  | 25.1% | 26.4% |  |
| 51-75th | 23.4% | 27.3% |  | 24.4% | 24.4% |  | 23.5% | 23.3% |  | 21.7% | 22.3% |  |
| 76-100th | 17.4% | 16.2% |  | 23.1% | 21.4% |  | 17.1% | 15.5% |  | 14.9% | 13.8% |  |
| Smoker | 31.0% | 27.5% | 0.45 | 30.8% | 31.0% | 0.80 | 36.5% | 32.4% | 0.001 | 36.8% | 34.2% | 0.015 |
| Alcohol misuse | 1.1% | 1.0% | 0.93 | 0.7% | 0.8% | 0.48 | 1.3% | 1.6% | 0.49 | 2.1% | 2.0% | 0.89 |
| Dyslipidemia | 74.2% | 72.6% | 0.71 | 76.8% | 74.6% | 0.001 | 74.3% | 70.9% | 0.003 | 70.7% | 68.9% | 0.073 |
| Hypertension | 75.2% | 71.6% | 0.42 | 76.4% | 77.9% | 0.022 | 74.3% | 76.4% | 0.075 | 74.8% | 77.9% | 0.001 |
| Diabetes mellitus | 35.8% | 38.2% | 0.61 | 37.1% | 42.7% | <0.001 | 35.8% | 42.3% | <0.001 | 39.9% | 47.8% | <0.001 |
| Obesity | 12.7% | 13.7% | 0.76 | 12.3% | 13.1% | 0.13 | 14.0% | 13.3% | 0.47 | 16.3% | 17.2% | 0.27 |
| Heart failure | 0.1% | 2.9% | <0.001 | 0.05% | 0.02% | 0.47 | 0.2% | 0.3% | 0.26 | 1.9% | 2.6% | 0.035 |
| Known coronary artery disease | 98.7% | 97.1% | 0.17 | 98.6% | 98.9% | 0.14 | 96.5% | 97.7% | 0.012 | 95.2% | 96.0% | 0.072 |
| Previous myocardial infarction | 16.0% | 18.6% | 0.47 | 14.9% | 15.5% | 0.30 | 12.6% | 12.8% | 0.85 | 13.3% | 13.8% | 0.53 |
| Previous percutaneous coronary intervention | 26.1% | 24.5% | 0.72 | 24.2% | 22.0% | 0.001 | 19.6% | 20.7% | 0.29 | 18.8% | 19.5% | 0.42 |
| Previous coronary artery bypass graft | 12.7% | 9.8% | 0.39 | 9.9% | 11.2% | 0.050 | 8.4% | 10.9% | 0.001 | 9.2% | 10.9% | 0.012 |
| Previous valve disease | 0.05% | 0.98% | 0.003 | 0.04% | 0.10% | 0.050 | 0.09% | 0.06% | 0.75 | 0.7% | 1.3% | 0.005 |
| Atrial fibrillation | 8.8% | 19.6% | <0.001 | 8.1% | 12.7% | <0.001 | 9.2% | 15.6% | <0.001 | 15.2% | 20.9% | <0.001 |
| Previous transient ischemic attack/stroke | 5.4% | 9.8% | 0.058 | 5.2% | 7.4% | <0.001 | 5.6% | 8.6% | <0.001 | 6.8% | 8.8% | 0.001 |
| Peripheral vascular disease | 11.6% | 13.7% | 0.50 | 11.2% | 14.5% | <0.001 | 11.9% | 15.2% | <0.001 | 15.0% | 20.3% | <0.001 |
| Pulmonary circulatory disorder | 0% | 1.0% | <0.001 | 0.02% | 0.05% | 0.17 | 0.04% | 0% | 0.46 | 0.4% | 0.6% | 0.076 |
| Peptic ulcer disease | 0.05% | 0% | 0.82 | 0.02% | 0% | 0.41 | 0.02% | 0% | 0.60 | 0.03% | 0.05% | 0.66 |
| Chronic lung disease | 12.7% | 17.7% | 0.15 | 11.6% | 16.1% | <0.001 | 13.4% | 19.8% | <0.001 | 18.7% | 26.1% | <0.001 |
| Renal failure | 10.6% | 20.6% | 0.002 | 9.2% | 16.6% | <0.001 | 11.8% | 17.9% | <0.001 | 19.7% | 29.6% | <0.001 |
| Liver disease | 1.0% | 1.0% | 0.96 | 0.7% | 1.1% | 0.009 | 0.8% | 2.1% | <0.001 | 1.6% | 2.1% | 0.15 |
| Hypothyroidism | 7.2% | 5.9% | 0.62 | 7.2% | 8.6% | 0.001 | 7.8% | 10.5% | <0.001 | 9.9% | 11.7% | 0.007 |
| Fluid and electrolyte disorders | 2.6% | 4.9% | 0.16 | 1.8% | 3.1% | <0.001 | 5.0% | 7.2% | <0.001 | 12.3% | 17.2% | <0.001 |
| Anemia | 5.5% | 9.8% | 0.066 | 3.9% | 7.9% | <0.001 | 6.0% | 10.7% | <0.001 | 14.0% | 20.9% | <0.001 |
| Cancer | 1.4% | 4.9% | 0.005 | 1.3% | 1.9% | <0.001 | 1.3% | 2.1% | 0.017 | 2.2% | 2.9% | 0.022 |
| Depression | 4.0% | 5.9% | 0.34 | 3.6% | 5.1% | <0.001 | 4.9% | 6.5% | 0.006 | 6.1% | 8.8% | <0.001 |
| Dementia | 0.4% | 0% | 0.53 | 0.5% | 0.7% | 0.082 | 0.9% | 1.7% | 0.001 | 1.3% | 1.8% | <0.001 |
| Charlson comorbidity index | 1.1±1.2 | 1.6±1.7 | <0.001 | 1.0±1.2 | 1.4±1.4 | <0.001 | 1.1±1.2 | 1.5±1.4 | <0.001 | 1.5±2.1 | 5.6±2.2 | <0.001 |
| Mean number of comorbidities | 4.6±1.9 | 5.0±2.2 | 0.027 | 4.5±1.7 | 4.8±1.9 | <0.001 | 4.5±1.8 | 5.0±2.0 | <0.001 | 5.0±2.1 | 5.6±2.2 | <0.001 |
| Bed size |  |  | 0.11 |  |  | 0.040 |  |  | 0.97 |  |  | 0.054 |
| Small | 9.8% | 3.9% |  | 9.6% | 8.8% |  | 6.9% | 6.8% |  | 5.6% | 4.9% |  |
| Medium | 21.4% | 19.6% |  | 17.6% | 16.6% |  | 21.9% | 22.2% |  | 20.0% | 22.0% |  |
| Large | 68.8% | 76.5% |  | 72.8% | 74.6% |  | 71.2% | 71.1% |  | 74.4% | 73.1% |  |
| Location |  |  | 0.75 |  |  | 0.61 |  |  | 0.76 |  |  | 0.80 |
| Rural | 0.1% | 0% |  | 0.2% | 0.1% |  | 0.3% | 0.3% |  | 0.3% | 0.4% |  |
| Urban | 99.9% | 100% |  | 99.8% | 99.9% |  | 99.7% | 99.7% |  | 99.7% | 99.6% |  |
| Teaching status |  |  | 0.31 |  |  | 0.58 |  |  | 0.64 |  |  | 0.33 |
| Nonteaching | 48.7% | 53.9% |  | 42.1% | 42.5% |  | 47.4% | 46.8% |  | 46.9% | 45.8% |  |
| Teaching status | 51.3% | 46.1% |  | 57.9% | 57.5% |  | 52.6% | 53.2% |  | 53.1% | 54.2% |  |
| Multivessel disease | 20.5% | 22.6% | 0.61 | 20.5% | 21.0% | 0.49 | 19.6% | 17.4% | 0.030 | 19.4% | 17.7% | 0.061 |
| Bifurcation | 3.9% | 2.9% | 0.64 | 4.2% | 3.8% | 0.23 | 3.2% | 3.5% | 0.53 | 19.4% | 17.7% | 0.34 |
| Fractional flow reserve | 4.6% | 3.9% | 0.77 | 2.8% | 3.1% | 0.38 | 2.2% | 2.8% | 0.090 | 2.3% | 2.5% | 0.62 |
| Intravascular ultrasound | 7.9% | 10.8% | 0.30 | 9.2% | 9.3% | 0.70 | 8.2% | 7.9% | 0.66 | 8.2% | 7.9% | 0.71 |
| Drug eluting stent | 80.9% | 70.6% | 0.011 | 82.8% | 76.7% | <0.001 | 78.4% | 74.9% | 0.001 | 72.8% | 67.5% | <0.001 |
| Cost for first admission | $14,436±7,022 | $16,113±10,774 | 0.024 | $14,190±6,541 | $14,190±6,465 | 0.99 | $17,464±7,994 | $17,144±7,508 | 0.13 | $23,087±14,042 | $24,175±14,066 | <0.001 |
| Cost of readmission | - | $11,504±11,789 | - | - | $10,915±16,279 | - | - | $10,817±13,041 | - | - | $12,328±18,548 | - |
| 30-day cost (first admission and readmission) | $14,436±7,022 | $27,617±16,650 | <0.001 | $14,190±6,541 | $24,974±18,186 | <0.001 | $17,465±7,995 | $27,879±15,894 | <0.001 | $23,087±14,042 | $36,425±24,662 | <0.001 |

**Table 3:** Cause of readmission according to length of stay

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Cause of readmission | 0 days (n=5,388) | | 1 day (n=216,469) | | 2 days (n=61,439) | | ≥3 days (n=68,154) | |
| % | p-value vs 0 days | % | p-value vs 0 days | % | p-value vs 0 days |
| Cardiac | 39.2% | 37.2% | | 0.68 | 42.1% | 0.57 | 41.8% | 0.60 |
| Non-cardiac | 60.8% | 62.8% | |  | 57.9% |  | 58.2% |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Cause of readmission (non-cardiac) | 0 days | 1 day | 2 days | ≥3 days |
| Non-specific chest pain | 12.7% | 10.8% | 10.9% | 7.5% |
| Infections | 5.9% | 6.0% | 4.5% | 6.3% |
| Gastrointestinal | 4.9% | 7.3% | 6.6% | 6.6% |
| Respiratory | 3.9% | 4.5% | 4.0% | 5.3% |
| Bleeding | 3.9% | 4.1% | 3.1% | 3.7% |
| Renal failure | 3.9% | 2.0% | 1.7% | 2.6% |
| Trauma | 2.9% | 2.0% | 1.8% | 0.8% |
| Genitourinary | 2.0% | 2.1% | 1.6% | 2.0% |
| Peripheral vascular disease | 2.0% | 2.7% | 2.3% | 2.6% |
| TIA/stroke | 2.0% | 2.6% | 3.2% | 2.6% |
| Endocrine/metabolic | 2.0% | 1.4% | 1.0% | 2.0% |
| Hematological/neoplasm | 0.0% | 2.0% | 2.5% | 1.8% |
| Rheumatological | 0.0% | 1.4% | 0.8% | 1.2% |
| Syncope | 0.0% | 1.2% | 0.9% | 1.1% |
| Neuropsychiatric | 0.0% | 0.9% | 1.7% | 0.7% |
| ENT problem | 0.0% | 0.9% | 0.4% | 0.6% |
| Opthalmological | 0.0% | 0.0% | 0.2% | 0.0% |
| Oral health problem | 0.0% | 0.1% | 0.0% | 0.1% |
| Obstetric or pregnancy problem | 0.0% | 0.0% | 0.1% | 0.0% |
| Dermatological | 0.0% | 0.0% | 0.1% | 0.0% |
| Poisoning | 0.0% | 0.0% | 0.1% | 0.4% |
| Other non-cardiac | 14.7% | 10.7% | 10.6% | 10.2% |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Cause of readmission (cardiac) | 0 days | 1 day | 2 days | ≥3 days |
| Angina and atherosclerotic heart disease (excluding acute myocardial infarction) | 17.6% | 19.4% | 18.0% | 13.5% |
| Acute myocardial infarction | 9.8% | 6.4% | 7.4% | 7.0% |
| Arrhythmias | 5.9% | 5.1% | 6.9% | 7.6% |
| Heart failure | 3.9% | 4.6% | 7.8% | 10.7% |
| Valve disorders | 1.0% | 0.4% | 0.2% | 0.6% |
| Conduction disorders | 0.0% | 0.5% | 0.5% | 0.3% |
| Pericarditis | 0.0% | 0.2% | 0.5% | 0.6% |
| Other cardiac | 1.0% | 0.7% | 0.8% | 1.3% |

**Figure 1:** Elective inpatient PCI procedures in the Nationwide Readmission Database according to length of stay

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**Figure 2:** Rate of readmission according to length of stay

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**Figure 3:** Total 30-day cost according to length of stay

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**Figure 4:** Adjusted odds of readmissions

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**Figure 5:** Cause of early readmissions after elective PCI



**Supplementary Figure 1:** Flow diagram of participant inclusion

Patients with elective PCI between 2010 and 2014 (n=423,894)

**Supplementary Table 1:** Classification of CCS codes for Readmissions Causes

Patients included in analysis (n=324,345)

Patients with unplanned readmission within 30 days of discharge 5.8% (n=18,781).

Patients not readmitted within 30 days of discharge 94.2% (n=305,564)

Patients excluded for the following reasons:

* Discharged in December of year of PCI (n=28,999)
* Death during PCI (n=3,900)
* Elective readmission (n=10,864)
* Not discharged home (n=28,680)
* Patient who received circulatory support or had an in-hospital complication such as complete heart block, stroke/transient ischemic attack, cardiogenic shock, acute kidney injury, major bleeding, vascular complication or emergency CABG (n=27,107)

Patients who died during admission for PCI (n=3,900)

|  |  |  |
| --- | --- | --- |
| Causes of readmission | CCS code | Diagnosis |
| Respiratory | 127 | Chronic obstructive pulmonary disease and bronchietasis |
| 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 | 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, 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 |
| 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 GI 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 dysrrhythmias |
| 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 |
| 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:** Independent predictors of readmissions within length of stay groups

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Variable | 0 days | | 1 day | | 2 days | | ≥3 days | |
| OR (95%CI) | p-value | OR (95%CI) | p-value | OR (95%CI) | p-value | OR (95%CI) | p-value |
| Age (per year increase) | 0.97 (0.95-1.00) | 0.023 | - | NS | - | NS | - | NS |
| Female sex | - | NS | 1.30 (1.20-1.41) | <0.001 | 1.34 (1.18-1.54) | <0.001 | 1.20 (1.08-1.33) | 0.001 |
| Year vs 2010  2014 | - | NS | 0.84 (0.71-1.00) | 0.049 | 0.78 (0.63-0.96) | 0.018 | - | NS |
| Primary expected payer vs Medicare  Private  Uninsured  Other | -  -  - | NS  NS  NS | 0.73 (0.66-0.81)  -  - | <0.001  NS  NS | 0.66 (0.43-0.80)  0.55 (0.37-0.83)  0.63 (0.43-0.92) | <0.001  0.005  0.018 | 0.69 (0.59-0.80)  -  - | <0.001  NS  NS |
| Dyslipidemia | - | NS | 0.89 (0.81-0.97) | 0.012 | 0.80 (0.69-0.93) | 0.003 | 0.87 (0.77-0.99) | 0.028 |
| Diabetes mellitus | - | NS | 1.17 (1.07-1.28) | 0.001 | 1.23 (1.07-1.41) | 0.004 | 1.26 (1.13-1.41) | <0.001 |
| Known coronary artery disease | - | NS | - | NS | 1.83 (1.24-2.71) | 0.002 | - | NS |
| Previous PCI | - | NS | 0.90 (0.81-0.99) | 0.024 | - | NS | - | NS |
| Valvular heart disease | - | NS | 7.30 (2.00-26.62) | 0.003 | - | NS | - | NS |
| Atrial fibrillation | 2.58 (1.23-5.43) | 0.012 | 1.52 (1.35-1.71) | <0.001 | 1.66 (1.38-1.99) | <0.001 | 1.33 (1.15-1.54) | <0.001 |
| Previous transient ischemic attack/stroke | 3.39 (1.71-6.72) | 0.001 | 1.27 (1.09-1.49) | 0.003 | - | NS | - | NS |
| Peripheral vascular disease | - | NS | 1.19 (1.04-1.35) | 0.010 | - | NS | - | NS |
| Chronic lung disease | - | NS | 1.33 (1.19-1.48) | <0.001 | 1.42 (1.20-1.69) | <0.001 | 1.39 (1.23-1.57) | <0.001 |
| Renal failure | - | NS | 1.57 (1.41-1.75) | <0.001 | 1.32 (1.07-1.64) | 0.005 | 1.37 (1.19-1.58) | <0.001 |
| Liver disease | - | NS | - | NS | 2.85 (1.60-5.10) | 0.001 | - | NS |
| Fluid and electrolyte disorder | 6.11 (1.63-22.89) | 0.007 | 1.47 (1.16-1.86) | 0.002 | - | NS | - | NS |
| Anemia | - | NS | 1.52 (1.31-1.78) | <0.001 | - | NS | 1.24 (1.07-1.44) | 0.005 |
| Depression | - | NS | 1.43 (1.15-1.77) | 0.001 | - | NS | 1.36 (1.10-1.67) | 0.004 |
| Drug eluting stent | - | NS | 0.75 (0.68-0.83) | <0.001 | - | NS | 0.81 (0.72-0.91) | 0.001 |

NS=not significant