**Unplanned hospital readmissions after acute myocardial infarction: A nationwide analysis of rates, trends, predictors and causes in the United States between 2010 and 2014**

Running title: Unplanned readmissions after AMI

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**Abstract**

**Background:** Unplanned hospital readmissions are an important quality metric for benchmarking but there is limited data following an acute myocardial infarction (AMI). This study aims to examine the 30-day unplanned readmission rate, predictors, causes and outcomes after hospitalization for AMI.

**Methods:** The U.S. Nationwide Readmission Database was utilized to analyze patients with a primary diagnosis of AMI between 2010-2014. Rates of readmissions, causes and costs were determined and multiple logistic regressions were used to identify predictors of readmissions. **Results:** Of 2,204,104 patients with AMI the 30-day unplanned readmission rate was 12.3%(n=270,510), which changed from 13.0%-11.5% between 2010-2014. The estimated impact of readmissions in AMI was ~694 million USD and ~279,000 additional bed days per year. Comorbidities such as diabetes (OR 1.27 95%CI 1.25-1.29), chronic lung disease (OR 1.29 95%CI 1.26-1.31), renal failure (OR 1.38 95%CI 1.35-1.40) and cancer (OR 1.35 95%CI 1.30-1.41) were independently associated with unplanned readmission. Discharge against medical advice was the variable most strongly associated with unplanned readmission (OR 2.40 95%CI 2.27-2.54). Non-cardiac causes for readmissions accounted for 52.9% of all readmissions. The most common cause of cardiac readmission was heart failure (14.3%) and for non-cardiac readmissions was infections (8.8%).

**Conclusions:** Readmissions during the first month after AMI occur in more than 1 in 10 patients resulting in a healthcare cost of ~694 million USD per year and ~279,000 additional bed days per year. These finding have important public health implications. Strategies to identify and reduce readmissions in AMI will dramatically reduce health care costs for society.

**Keywords:** acute myocardial infarction; readmissions; cost

**Introduction**

Acute myocardial infarction (AMI) is one of the most common reasons for hospital admission accounting for nearly 2.5 million admissions between 2001 and 2007 in the United States [1]. Its effect on health services is significant; it is one of the ten most expensive conditions costing $12.1 billion in 2013 [2]. Its impact on the population is substantial causing 114,023 deaths in-hospital in 2015 and a study of Medicare beneficiaries estimated that 20.6% of patients are rehospitalized within 10 years of an index myocardial infarction [3]. Survival rates have improved over time with the development of coronary care units, reperfusion through thrombolysis and more recently primary percutaneous coronary intervention with a reduction of recurrent ischemic events by potent antithrombotic medications [4]. Increased survival has in turn created a population at risk of unplanned hospital readmissions.

Unplanned hospital readmissions are important for several reasons. They are taxing to patients and healthcare services. Readmissions reduce the total health resources available to deliver care and represent an unnecessary cost burden. Increasingly, readmissions are being used as a benchmark for quality of care[5] reflective of actions taken or omitted during the initial hospital stay [6]. Lastly, the Affordable Care Act creates financial penalties for hospitals that have risk adjusted readmission rates for specific conditions exceeding specific benchmarks [7].

Readmissions after AMI may arise for several reasons. They may be related to complications of AMI, including bleeding complication or the development of heart failure [8.9]. They may be related to inadequate management of other comorbidities during a patient’s hospital stay [10]. Finally, they may be the result of insufficient follow-up care. Understanding reasons for readmissions is necessary to reconfigure healthcare services to improve the quality to patients and reduce healthcare expenditures. While there have been published studies evaluating readmissions after AMI, these studies have been few and small [10,11], have evaluated specific groups such as young patients[12] or patients with cardiogenic shock[13] or limited in duration[14,15].

The objective of the current study is to evaluate the rate, trends, predictors and causes of unplanned readmissions after AMI (STEMI and NSTEMI) in the United States.

**Methods**

*Participants and study design*

The NRD is a nationally representative data sample that includes all-age, all-payer discharges from US non-federal hospitals produced by the Healthcare Cost and Utilization Project of the Agency for Healthcare Research and Quality [16]. This includes records from discharge-level data of hospitalizations from 21 geographically-dispersed participating states representing 49.3% of the total US population and 49.1% of all US hospitalizations [17]. Each patient has a unique de-identified linkage number, which is used to identify readmissions, which allows tracking of patients across hospitals within a state during a calendar year.

We included patients diagnosed with AMI discharged between 2010 and 2014 with 30-day follow up. Individuals in the NRD dataset are assigned 25 International Classification of Disease-9 (ICD-9) diagnostic codes for each year between 2010 to 2013 and 30 diagnostic ICD-9 codes for 2014 for each admission to hospital. The code 4107\* was used to define non-ST elevation myocardial infarction (NSTEMI) and codes 4100\*, 4101\*, 4102\*, 4103\*, 4104\*, 4105\*, 4106\*, 4108\* and 4109\* was used to define ST-elevation myocardial infarction (STEMI). AMI was defined by the composite of NSTEMI and STEMI and represents the population of the current study. Using the discharge disposition variable (DISPUNIFORM) we excluded patients who died during their inpatient stay. The ELECTIVE variable was used to exclude planned readmissions within 30 days. We excluded patients admitted in December in the included calendar years because they would not have 30-day follow up. This was done because the data was annualized and was not trackable across years.

*Outcomes and measurements*

The primary outcome was the rate of unplanned readmission within 30 days of hospitalization. Total 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.

We used ICD-9 codes to define clinical variables including smoking status, dyslipidemia, coronary artery disease, previous myocardial infarction, previous PCI, previous CABG, previous stroke or TIA, atrial fibrillation, dementia and receipt of circulatory support. The other comorbidity variables in the analysis were available via the Elixhauser comorbidities which included alcohol misuse, chronic lung disease, previous 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, 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. The number of comorbidities was the sum of the comorbidities included in the analysis. Procedural ICD-9 codes were used to define circulatory support, vasopressor use, intra-aortic balloon pump use, ventilation, drug eluting stent use and receipt of coronary angiogram, percutaneous coronary intervention (PCI), thrombolysis, coronary artery bypass graft, implantable cardioverter defibrillator/pacemaker and left ventricular assist device. Diagnostic ICD-9 codes were used to define in-hospital outcomes including complete heart block, ventricular fibrillation, ventricular tachycardia, transient ischemia attack or stroke, cardiogenic shock, cardiac arrest, acute kidney injury, major bleeding, blood transfusion and vascular complication. 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 readmission were determined by the first diagnosis based on Clinical Classification Software codes which are presented in detail in Supplementary Table 1.

*Statistical analysis*

Statistical analysis was performed on Stata 14.0 (College Station, TX). Descriptive statistics are presented according to readmission status for 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. Trends in readmission were examined graphically overall and in the subgroup of patients based on gender, age-group and diagnosis. Time to readmission was explored using histograms. Multiple logistic regressions were used to identify independent predictors of 30-day readmissions after AMI. The logistic regression models were adjusted for age, sex, year, elective admission, weekend admission, diagnosis of STEMI, primary expected payer, median household income, smoking, alcohol misuse, dyslipidemia, hypertension, diabetes mellitus, obesity, previous 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, circulatory support, vasopressor use, ventilation, intra-aortic balloon pump use, drug eluting stent, receipt of coronary angiogram, PCI, thrombolysis, CABG, in-hospital complete heart block, ventricular fibrillation, ventricular tachycardia, transient ischemic attack or stroke, cardiogenic shock, cardiac arrest, acute kidney injury, major bleeding, blood transfusion, vascular complications, length of stay and discharge destination. An additional regression was performed to evaluate the predictive value of Charlson comorbidity index on readmission status. The mean cost of index admission for AMI and the costs associated with readmissions were computed and are shown graphically. The causes of readmission within 30 days are presented in figure format as (a) non-cardiac and (b) cardiac. A flow diagram was used to describe patient outcomes (in-hospital death) for both admissions and readmissions.

**Results**

A total of 2,663,019 patients were admitted with AMI between 2010 and 2014 (Figure 1). After exclusion of discharges in the month of December, those who died in hospital and those that had an elective readmission, there were 2,204,104 patients. The 30-day readmission rate was 12.3% (n=270,510). The rate of 30-day readmissions declined over time from 13.0% in 2010 to 11.5% in 2014 (Figure 2). This decline was greatest amongst patients who were female, age ≥75 years and with a NSTEMI diagnosis (Figure 2).

Patients who were older (70.3 vs 66.4 years, p<0.001) and female (44.6% vs 37.2%, p<0.001) were more likely to be readmitted (Table 1). A diagnosis of STEMI (25.4% vs 31.5%, p<0.001) and private healthcare (15.0% vs 27.2%) were associated with fewer readmissions. Comorbid burden was associated with readmission; diabetes (44.6% vs 35.3%, p<0.001), renal failure (30.6% vs 17.7%, p<0.001) and anemia (25.3% vs 15.5%, p<0.001) were most associated with early readmissions. Treatment factors including receipt of a drug eluting stent (26.0% vs 37.8%, p<0.001), a coronary angiogram (64.8% vs 78.0%, p<0.001) or PCI (40.3% vs 52.8%, p<0.001) were associated with a reduced unplanned readmission. Patients readmitted had slightly longer inpatient stay for index AMI (5.4 vs 5.0 days). The mean time to readmission was 14.8 days, which was shorter for cardiac causes for readmissions and longer for non-cardiac causes for readmissions (Supplementary Figure 1). The mortality rate of the readmission episode was 4.8% (lower than the 5.6% observed for index PCI).

The cost of index admission for AMI was $21,200 and the total cost from readmitted patients (index admission and unplanned readmissions within 30-day) was $33,113 as depicted in Figure 3. The impact of readmissions related to AMI is estimated to be ~694 million USD per year and ~279,000 additional bed days per year.

Independent variables associated with unplanned readmission are shown in Table 2 (Supplementary Table 2). Smoking (OR 0.94 95%CI 0.92-0.95, p<0.001) and obesity (OR 0.94 95%CI 0.92-0.96, p<0.001) were both associated with fewer unplanned readmissions. The comorbidities most associated with unplanned readmissions where diabetes (OR 1.27 95%CI 1.25-1.29, p<0.001), chronic lung disease (OR 1.29 95%CI 1.26-1.31, p<0.001), renal failure (OR 1.38 95%CI 1.35-1.40, p<0.001), liver disease (OR 1.32 95%CI 1.25-1.39, p<0.001) and cancer (OR 1.35 95%CI 1.30-1.41, p<0.001). Previous heart failure was associated with reduced odds of unplanned readmissions (OR 0.74 95%CI 0.68-0.79, p<0.001). Institutional factors associated with reduced odds of unplannedreadmissions included private healthcare (OR 0.65 95%CI 0.63-0.67, p<0.001), uninsured healthcare (OR 0.67 95%CI 0.64-0.70, p<0.001) and teaching hospital care (OR 0.96 95%CI 0.94-0.98, p<0.001). The major treatment factors associated with reduced odds of unplanned readmissions were drug eluting stent (OR 0.78 95%CI 0.76-0.84, p<0.001), receipt of angiogram (OR 0.78 95%CI 0.76-0.84, p<0.001) and receipt of CABG (OR 0.70 95%CI 0.67-0.72, p<0.001). Discharge against medical advice was the single variable most associated with unplanned readmission (OR 2.40 95% CI 2.27-2.54, p<0.001).

Cardiac causes accounted for 47.1 percent of all readmissions (Figure 4 and Supplementary Table 3). The most common causes of cardiac readmission were heart failure (14.3%), AMI (13.2%) and coronary artery disease including angina (10.3%). Non cardiac causes which accounted for 52.9 percent of readmissions included Infections (8.8%), respiratory illnesses (5.2%), non-specific chest pain (5.1%) and gastrointestinal illnesses (4.8%) which were among the most common.

The proportion of readmissions for AMI increased over time whilst for non-cardiac causes the proportion of readmissions related to infection and renal failure increased over time (Figure 3).

**Discussion**

Our study reveals the significant burden of unplanned readmissions after AMI with more than one in ten patients readmitted within 30 days with an associated cost of ~694 million USD per year and ~279,000 additional bed days per year. Readmissions appear to have declined over time, which is most apparent in patients who are female, elderly or with a diagnosis of NSTEMI. Variables associated with unplanned readmissions post AMI were comorbidities including diabetes, chronic lung disease, renal failure, liver failure and cancer. Non-cardiac causes represent the commonest causes for unplanned readmissions and account for more than half of all readmissions following AMI. The single most common cause for readmission was heart failure (14.2%) and the most common non-cardiac cause for readmission were infections (8.8%). Institutional factors associated with fewer unplanned readmissions were private care, uninsured patients and teaching hospital care whilst the single variable most associated with unplanned readmission was discharge against medical advice. Consideration of measures to minimize readmissions in the design of cardiology services may improve patient outcomes and reduce healthcare expenditures.

Prior studies have reported higher rates of readmissions compared to our study. An analysis of the Medicare Fee-For-Service claims data between 2007 and 2009 reported 548,834 readmissions after acute myocardial infarction suggesting an overall rate of 19.9% with heart failure as the most common cause [18]. The readmission rate in the current study is much lower at 12.3% because of the more contemporary cohort (2010-2014) and planned readmissions were excluded. Furthermore, Medicare patients only represent 57% of the population in the current study and had the highest rates of unplanned readmissions (15.1%).

We have shown that the economic and healthcare burden of unplanned readmissions in the context of AMI is significant, thus reducing unplanned readmission is an area of importance from a health economic perspective. Previous work has suggested that 14.5% of all hospital admissions result in an unplanned readmission within 30 days, costing the US healthcare economy 50.7 billion USD [19]. While some of the readmissions may not be preventable, it is likely that a proportion may have been avoidable. Targeted areas to reduce the burden of readmissions in the AMI setting could include the index hospitalization, post discharge and outpatient space and during any re-presentation to the emergency department [20]. Only one specific intervention has been described in the literature designed to reduce readmissions in AMI. That report describes the use of cardiac rehabilitation to enhance the patient/family’s retention and understanding of discharge instructions including symptom management and medication reconciliation [21]. In the context of PCI, it is estimated that nearly half of 30-day readmissions may be prevented by changes in clinical decision-making and addressing specific identified preventable causes including vascular bleeding and congestive heart failure [22]. While longer hospital length of stay might increase healthcare expenditure, it is not clear whether it would allow for more time to optimize management and allow referrals to other specialties to address non-cardiac issues. Discharge checklists have been highlighted as useful in the transition to outpatient care[23] as may allow early follow up in an outpatient setting. The key may be risk stratification as several tools have been developed to target readmissions. While risk assessments have been developed for readmission for PCI and the general population[24,25] there are currently no such tools for AMI.

Socioeconomic status has been shown to influence inpatient survival after acute myocardial infarction [26]. Interestingly, our study indicates that both extremes of insurance status, private vs uninsured, significantly reduced the risk of unplanned readmission. While private insurance status might be expected to predict access to medications, cardiac rehabilitation programs, and timely medical follow up, all of which likely reduce the need for readmission, the relationship between lack of insurance and reduced readmission rates is not as easily explained. It is possible that uninsured patients have higher 30-day mortality after discharge or simply avoid readmission because of financial concerns. These questions should be addressed in future analyses.

We discovered that non-cardiac problems accounted for half of the unplanned readmissions after AMI. The most common diagnoses were infections, non-specific chest pain, respiratory disease and gastrointestinal disease. Interestingly, we observed that infections were the most common non-cardiac cause of early unplanned readmissions. AMI can influence immunity making patients more predisposed to infectious complications. Analysis from the APEX-AMI trial of 5745 patients suggests that 2.4% developed serious infection [27]. Infectious complications were more frequent in sicker patients with a prior history of inflammatory disease, chronic obstructive pulmonary and diabetes. Recognition of serious infections in the context of AMI is important because they are associated with a 5-fold increase in death or subsequent myocardial infarction at 90-days. Another retrospective case-control study of 1227 AMI patients revealed that 5% had an infectious complication [28]. The most common site of infection was the lungs (63%) followed by the urinary tract (37%).

As heart failure was found to be the single most common cause for unplanned early readmission interventions should perhaps be aimed to reduce readmissions related to such. A simple measure may be use of routine echocardiography to assess left ventricular function during index AMI and a pathway of referral to outpatient heart failure services for patients who are identified to have left ventricular impairment. It has been shown that early follow up reduces heart failure readmissions[29] and perhaps this should be offered to patients with a reduction in left ventricular ejection fraction after AMI. In addition, it is important that information regarding the left ventricular function at time of discharge be transmitted from the current care providers to future care providers who may manage the patient. Use of patient education videos may better educate patients about symptoms and when and where to seek health services for heart failure.

We observed a higher rate of unplanned readmissions among women (44.6%) compared to men (37.2%). Gender differences in readmissions after AMI in the Nationwide Readmission Database have been previous reported and discussed by O’Brien et al [15]. They suggest younger women with AMI are a distinct group with atypical symptoms, a different risk factor profile and have worse outcomes compared to men and are less likely to receive guideline based therapies. Women have a significantly lower burden of obstructive CAD relative to men but this does not confer protection from CVD events [30]. Excess cardiovascular risk in women is independently associated with a phenotype less amenable to revascularization, and potentially less likely to receive guidelines recommended therapies.

Our study highlights the importance of comorbidities in readmissions after AMI. The prevalence of comorbidities may reflect the growing population of patients who are elderly and comorbid. A study of 9,581 patients from 11 medical centers in Massachusetts has shown that that the proportion of patients without comorbidities has declined between years 1990 and 2007, and that an increasing number of comorbidities in patients hospitalized with AMI was associated with higher rates of mortality [31]. Awareness of comorbidities is important as interventions aimed to reduce readmissions could potentially target comorbid conditions. There are no current studies of interventions that target specific comorbidities in the care of patients with AMI in order to mitigate readmission risk. However, in the context of PCI, a multicomponent intervention with a risk assessment that includes comorbidities, educational videos, a discharge checklist with consideration of diabetes and a notification of readmission for rapid assessment of chest discomfort can reduce readmissions [20]. In addition, comorbidities complicate the risk profile for patients and could influence management decisions. For example, frailty and comorbidities make a patient high risk for PCI but if coronary revascularization is not performed, reinfarction or other sequalae of coronary ischemia may occur resulting in a readmission. Also, the risk of specific causes for readmissions may be influenced by management choices made in the index admission. A patient with myocardial infarction may be managed with PCI or CABG and the potential complications contributing to readmissions may depend on the treatment modality. The bleeding risk may be greater with PCI because of dual antiplatelet therapy whereas the infection risk may be higher with CABG.

We observed that smokers and obese patients were protected from unplanned readmissions. The smoker’s paradox has been reported such that smokers with acute coronary syndrome have lower mortality compared to non-smokers explained because smokers are of younger age, lower comorbidity and receive more aggressive treatments compared to non-smokers [32]. These differences in characteristics and treatment may also explain the reduction in readmissions. In addition, it has been argued that smoking predicts better outcome after reperfusion strategies because smokers are more likely to undergo these procedures at a much younger age and among patients with fewer comorbidities [33]. Another potential mechanism is that smokers have better follow up in the community via clinic and rehabilitation to support smoking cessation or because of more severe coronary disease attributed to smoking. Improved follow up compared to standard care may deter unplanned early readmissions. It has been suggested that the obesity paradox may be explained by either a confounding effect due to one or several confounders in the obese population or biological factors in the obese phenotype which protect obese patients from cardiovascular disease and premature death [34]. Similar to smoking, obese patients are younger compared to non-obese patients at time of myocardial infarction [35] and they are more likely to receive aggressive disease modifying treatment [34] and be referred to experts for secondary prevention [36]. Another explanation may be that obesity may be protective against malnutrition and energy wastage post revascularization and altered neuroendocrine status in obese patients may play a role in modulating progression of pathological cardiac remodeling after myocardial infarction [34]. These factors may also mitigate or influence unplanned readmissions among obese patients.

Our study has several strengths. It is the largest study to date of readmissions after AMI. Secondly, the Nationwide Readmission Database is nearly complete for the variables in the current study. The data is designed to be generalizable to hospitals in the United States rather than specific to a geographic area. Finally, we were able to consider the effect of a variety of patient characteristics, hospital-related, and outcome-related variables and their influence on readmission rates.

Our study has a few limitations. The data is derived from five unique datasets corresponding to each year period between 2010 to 2014 so we were unable to track patients across years. In order to ensure adequate 30-day follow up patients discharged in the month of December were excluded. The database does not capture data regarding medications, which may influence complications after AMI. The present analysis is retrospectively collected data from administrative claims from 21 states where regional heterogeneity could not be explored. However, such random variation would not influence the overall results. In addition, we cannot exclude possible bias from coding errors and we had to use the primary discharge diagnosis code for cause of readmissions, which may be subject to bias. Survivorship is an important influencing factor in the current study. Our study is limited because mortality within 30-days of AMI that occurs outside of hospital settings are not captured and this may lead to under estimation of readmissions. While out-of-hospital deaths may not contribute to cost burdens to health services, it may alter the rates for specific causes for readmissions as life threatening causes may be under-represented. Survivorship bias is complex as it reduces the cohort eligible for readmission and changes the risk profile of patients who are eligible for readmission.

In conclusion, our study demonstrates that readmissions after AMI are common affecting more than 10% of patients with a substantial healthcare cost burden. Comorbidities were strong predictors of readmissions and although heart failure was the most common single cause of readmission, majority of causes were non-cardiac. These findings suggest that interventions designed to reduce readmissions need to be integrated in the design of cardiology services in order to improve patients’ outcomes and mitigate the unnecessary costs associated with preventable readmissions.

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

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**Figure 2:** Trends in readmissions over time

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**Figure 3:** Cost of index, readmission and total cost

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**Figure 4:** Causes of 30-day unplanned readmissions

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**Figure 5:** Changes in cause of readmission over time

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**Table 1:** Characteristics of patients with primary diagnosis of acute myocardial infarction according to 30-day unplanned readmissions status

|  |  |  |  |
| --- | --- | --- | --- |
| Variable | No readmission (n=832,624) | Readmission within 30-days (n=270,510) | P-value |
| Age (year) | 66.4±14.0 | 70.3±13.7 | <0.001 |
| Female | 37.2% | 44.6% | <0.001 |
| Weekend admission | 27.0% | 26.7% | 0.040 |
| Year  2010  2011  2012  2013  2014 | 18.9%  18.8%  19.1%  21.1%  22.0% | 20.2%  19.9%  19.4%  20.2%  20.4% | <0.001 |
| Diagnosis of STEMI | 31.5% | 25.4% | <0.001 |
| Primary expected payer  Medicare  Medicaid  Private  Uninsured  No charge  Other | 54.7%  7.1%  27.2%  6.5%  0.8%  3.7% | 69.8%  8.2%  15.0%  3.8%  0.5%  2.7% | <0.001 |
| Median household income centile  0-25th  26-50th  51-75th  76-100th | 29.0%  25.5%  24.1%  21.3% | 30.9%  25.7%  23.3%  20.1% | <0.001 |
| Smoking | 41.2% | 36.0% | <0.001 |
| Alcohol misuse | 3.4% | 3.3% | 0.038 |
| Dyslipidemia | 64.4% | 60.5% | <0.001 |
| Hypertension | 72.3% | 76.4% | <0.001 |
| Diabetes mellitus | 35.3% | 44.6% | <0.001 |
| Obesity | 15.5% | 14.4% | <0.001 |
| Heart failure | 1.2% | 1.3% | <0.001 |
| Coronary artery disease | 81.2% | 78.8% | <0.001 |
| Previous myocardial infarction | 11.6% | 13.5% | <0.001 |
| Previous PCI | 14.5% | 15.4% | <0.001 |
| Previous CABG | 7.9% | 10.9% | <0.001 |
| Valvular heart disease | 0.4% | 0.4% | 0.025 |
| Atrial fibrillation | 15.9% | 22.8% | <0.001 |
| Previous stroke/TIA | 8.4% | 11.9% | <0.001 |
| Peripheral vascular disease | 11.2% | 16.4% | <0.001 |
| Pulmonary circulatory disorder | 0.2% | 0.2% | 0.34 |
| Peptic ulcer disease | 0.03% | 0.04% | 0.055 |
| Chronic lung disease | 19.4% | 27.2% | <0.001 |
| Renal failure | 17.7% | 30.6% | <0.001 |
| Liver disease | 1.4% | 2.2% | <0.001 |
| Hypothyroidism | 10.6% | 13.1% | <0.001 |
| Fluid and electrolyte disorders | 19.9% | 26.7% | <0.001 |
| Anemia | 15.5% | 25.3% | <0.001 |
| Cancer | 2.5% | 4.2% | <0.001 |
| Depression | 7.3% | 9.0% | <0.001 |
| Dementia | 6.0% | 8.8% | <0.001 |
| Charlson score | 1.4±1.6 | 2.1±1.8 | <0.001 |
| Bedsize  Small  Medium  Large | 7.2%  23.1%  69.8% | 7.5%  23.8%  68.7% | <0.001 |
| Urban location | 94.0% | 93.6% | <0.001 |
| Teaching hospital | 57.4% | 55.2% | <0.001 |
| Circulatory support | 4.1% | 4.3% | <0.001 |
| Vasopressor use | 0.7% | 0.7% | 0.11 |
| Intra-aortic balloon pump use | 3.9% | 4.1% | <0.001 |
| Ventilation | 4.1% | 4.2% | 0.17 |
| Drug eluting stent | 37.8% | 26.0% | <0.001 |
| In-hospital events |  |  |  |
| Complete heart block | 1.1% | 1.1% | 0.78 |
| Ventricular fibrillation | 2.4% | 1.9% | <0.001 |
| Ventricular tachycardia | 5.7% | 5.4% | 0.003 |
| Stroke/TIA | 3.6% | 4.4% | <0.001 |
| Cardiogenic shock | 3.8% | 4.2% | <0.001 |
| Cardiac arrest | 1.9% | 1.7% | <0.001 |
| Acute kidney injury | 1.1% | 1.7% | <0.001 |
| Major bleeding | 1.5% | 2.1% | <0.001 |
| Blood transfusion | 0.4% | 0.4% | 0.097 |
| Vascular complication | 0.6% | 0.6% | 0.13 |
| Receipt of coronary angiogram | 78.0% | 64.8% | <0.001 |
| Receipt of PCI | 52.8% | 40.3% | <0.001 |
| Receipt of thrombolysis | 1.4% | 1.1% | <0.001 |
| Receipt of CABG | 9.7% | 8.0% | <0.001 |
| Receipt of ICD/pacemaker | 1.2% | 1.3% | 0.081 |
| Receipt of LV assist device | 0.2% | 0.2% | 0.18 |
| Length of stay (days) | 5.0±6.3 | 5.4±4.2 | <0.001 |
| Cost of index admission (USD) | $21,386±21,495 | $19,868±16,975 | <0.001 |
| Cost of readmission (USD) | - | $13,270±19,246 | - |
| Cost of index admission and readmission USD) | $21,386±21,495 | $33,112±26,935 | <0.001 |
| Discharge location  Home (self-care)  Short-term hospital  Care home  Discharge against medical advice or discontinued care | 72.0%  14.3% 12.8%  0.9% | 57.8%  21.2% 18.8%  2.1% | <0.001 |
| Time to readmission (days)  Median (IQR)  Mean (SD) | -  - | 14 (8-21)  14.8±7.8 | - |
| Readmission length of stay (days)  Median (IQR)  Mean (SD) | -  - | 3 (2-6)  5.2±6.2 | - |
| Readmission death | - | 4.8% | - |

P-value from T-test for continuous variables and Chi2-test for categorical variables.

SD = standard deviation, IQR = interquartile range, USD = US dollars, STEMI = ST segment elevated myocardial infarction, PCI = percutaneous coronary intervention, CABG = coronary artery bypass graft, TIA = transient ischemic attack

**Table 2:** Independent predictors of 30-day unplanned readmissions

|  |  |  |
| --- | --- | --- |
| Variable | Odds ratio (95% CI) | p-value |
| Female | 1.13 (1.11-1.15) | <0.001 |
| Year vs 2010  2012  2013  2014 | 0.93 (0.90-0.96)  0.88 (0.86-0.91)  0.85 (0.83-0.88) | <0.001  <0.001  <0.001 |
| Diagnosis of STEMI | 1.02 (1.00-1.04) | 0.025 |
| Primary expected payer vs Medicare  Medicaid  Private  Uninsured  No charge  Other | 1.09 (1.06-1.13)  0.65 (0.63-0.67)  0.67 (0.64-0.70)  0.77 (0.68-0.86)  0.74 (0.71-0.78) | <0.001  <0.001  <0.001  <0.001  <0.001 |
| Median household income vs 0-25th  26-50th  51-75th  76-100th | 0.97 (0.95-0.99)  0.94 (0.91-0.96)  0.94 (0.92-0.97) | 0.008  <0.001  <0.001 |
| Smoking | 0.94 (0.92-0.95) | <0.001 |
| Dyslipidemia | 0.91 (0.89-0.92) | <0.001 |
| Hypertension | 1.06 (1.04-1.08) | <0.001 |
| Diabetes mellitus | 1.27 (1.25-1.29) | <0.001 |
| Obesity | 0.94 (0.92-0.96) | <0.001 |
| Coronary artery disease | 1.07 (1.05-1.10) | <0.001 |
| Previous myocardial infarction | 1.08 (1.06-1.11) | 0.015 |
| Previous PCI | 1.05 (1.02-1.07) | <0.001 |
| Previous CABG | 1.07 (1.04-1.07) | <0.001 |
| Atrial fibrillation | 1.22 (1.19-1.24) | <0.001 |
| Previous stroke/TIA | 1.11 (1.09-1.14) | <0.001 |
| Peripheral vascular disease | 1.19 (1.16-1.21) | <0.001 |
| Chronic lung disease | 1.29 (1.26-1.31) | <0.001 |
| Renal failure | 1.38 (1.35-1.40) | <0.001 |
| Fluid and electrolyte disorder | 1.10 (1.07-1.13) | <0.001 |
| Anemia | 1.23 (1.21-1.26) | <0.001 |
| Depression | 1.10 (1.07-1.13) | <0.001 |
| Dementia | 0.93 (0.90-0.95) | <0.001 |
| Urban location | 1.07 (1.03-1.11) | 0.001 |
| Teaching hospital | 0.96 (0.94-0.98) | <0.001 |
| Receipt of ventilation | 0.85 (0.81-0.89) | <0.001 |
| Drug eluting stent | 0.78 (0.76-0.80) | <0.001 |
| Ventricular tachycardia | 1.04 (1.00-1.07) | 0.029 |
| Receipt of angiogram | 0.78 (0.76-0.84) | <0.001 |
| Receipt of PCI | 1.06 (1.03-1.09) | <0.001 |
| Receipt of CABG | 0.70 (0.67-0.72) | <0.001 |
| Discharge location vs home (self-care)  Short-term hospital  Care home  Discharge against medical advice or discontinued care | 1.21 (1.18-1.25)  1.31 (1.28-1.35)  2.40 (2.27-2.54) | <0.001  <0.001  <0.001 |

STEMI = ST-elevation myocardial infarction, PCI = percutaneous coronary intervention, CABG = coronary artery bypass graft, TIA = transient ischemic attack.

\*Only variable with greater than 5% prevalence are shown. Complete table shown in Supplementary Table 2

**Supplementary Figure 1:** Time to readmission for all readmission, cardiac readmissions and non-cardiac readmissions

**A) All readmissions**

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**B) Cardiac readmissions**

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**C) Non-cardiac readmissions**

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**Supplementary Table 1:** Classification of Clinical Classifications Software (CCS) 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 | Human Immunodeficiency Virus (HIV) infection |
| 6 | Hepatitis |
| 7 | Viral infection |
| 8 | Other infection |
| 9 | Sexually transmitted infection |
| 76 | Meningitis |
| 77 | Encephalitis |
| 78 | Other central nervous system 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; placental abruption; 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 |
| Transient ischemic attack/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 | Leukemia |
| 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 |
| Ophthalmology 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 |
| 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 30-day unplanned readmissions

|  |  |  |
| --- | --- | --- |
| Variable | Odds ratio (95% CI) | p-value |
| Female | 1.13 (1.11-1.15) | <0.001 |
| Year vs 2010  2012  2013  2014 | 0.93 (0.90-0.96)  0.88 (0.86-0.91)  0.85 (0.83-0.88) | <0.001  <0.001  <0.001 |
| Diagnosis of STEMI | 1.02 (1.00-1.04) | 0.025 |
| Primary expected payer vs Medicare  Medicaid  Private  Uninsured  No charge  Other | 1.09 (1.06-1.13)  0.65 (0.63-0.67)  0.67 (0.64-0.70)  0.77 (0.68-0.86)  0.74 (0.71-0.78) | <0.001  <0.001  <0.001  <0.001  <0.001 |
| Median household income vs 0-25th  26-50th  51-75th  76-100th | 0.97 (0.95-0.99)  0.94 (0.91-0.96)  0.94 (0.92-0.97) | 0.008  <0.001  <0.001 |
| Smoking | 0.94 (0.92-0.95) | <0.001 |
| Alcohol misuse | 1.07 (1.02-1.12) | 0.002 |
| Dyslipidemia | 0.91 (0.89-0.92) | <0.001 |
| Hypertension | 1.06 (1.04-1.08) | <0.001 |
| Diabetes mellitus | 1.27 (1.25-1.29) | <0.001 |
| Obesity | 0.94 (0.92-0.96) | <0.001 |
| Heart failure | 0.74 (0.68-0.79) | <0.001 |
| Coronary artery disease | 1.07 (1.05-1.10) | <0.001 |
| Previous myocardial infarction | 1.08 (1.06-1.11) | 0.015 |
| Previous PCI | 1.05 (1.02-1.07) | <0.001 |
| Previous CABG | 1.07 (1.04-1.07) | <0.001 |
| Atrial fibrillation | 1.22 (1.19-1.24) | <0.001 |
| Previous stroke/TIA | 1.11 (1.09-1.14) | <0.001 |
| Peripheral vascular disease | 1.19 (1.16-1.21) | <0.001 |
| Pulmonary circulatory disorder | 0.79 (0.65-0.95) | 0.012 |
| Chronic lung disease | 1.29 (1.26-1.31) | <0.001 |
| Renal failure | 1.38 (1.35-1.40) | <0.001 |
| Liver disease | 1.32 (1.25-1.39) | <0.001 |
| Fluid and electrolyte disorder | 1.10 (1.07-1.13) | <0.001 |
| Anemia | 1.23 (1.21-1.26) | <0.001 |
| Cancer | 1.35 (1.30-1.41) | <0.001 |
| Depression | 1.10 (1.07-1.13) | <0.001 |
| Dementia | 0.93 (0.90-0.95) | <0.001 |
| Urban location | 1.07 (1.03-1.11) | 0.001 |
| Teaching hospital | 0.96 (0.94-0.98) | <0.001 |
| Receipt of ventilation | 0.85 (0.81-0.89) | <0.001 |
| Drug eluting stent | 0.78 (0.76-0.80) | <0.001 |
| Ventricular tachycardia | 1.04 (1.00-1.07) | 0.029 |
| Receipt of angiogram | 0.78 (0.76-0.84) | <0.001 |
| Receipt of PCI | 1.06 (1.03-1.09) | <0.001 |
| Receipt of CABG | 0.70 (0.67-0.72) | <0.001 |
| Receipt of ICD/pacemaker | 0.90 (0.84-0.97) | 0.006 |
| Receipt of LV assist device | 0.69 (0.51-0.93) | 0.015 |
| Discharge location vs home (self-care)  Short-term hospital  Care home  Discharge against medical advice or discontinued care | 1.21 (1.18-1.25)  1.31 (1.28-1.35)  2.40 (2.27-2.54) | <0.001  <0.001  <0.001 |

STEMI = ST-elevation myocardial infarction, PCI = percutaneous coronary intervention, CABG = coronary artery bypass graft, TIA = transient ischemic attack, ICD = implantable cardioverter defibrillator, LV = left ventricular

**Supplementary Table 3:** Causes of unplanned 30-day readmissions

|  |  |
| --- | --- |
| Causes of 30-day readmissions | % |
| Non-cardiac | 52.9 |
| Cardiac | 47.1 |

|  |  |
| --- | --- |
| Causes of non-cardiac readmissions | % |
| Infections | 8.8 |
| Non-specific chest pain | 5.2 |
| Respiratory | 5.1 |
| Gastrointestinal | 4.7 |
| TIA/stroke | 2.8 |
| Bleeding | 2.6 |
| Renal failure | 2.6 |
| Peripheral vascular disease | 2.3 |
| Genitourinary | 1.7 |
| Hematological/neoplasm | 1.7 |
| Endocrine/metabolic | 1.7 |
| Neuropsychiatric | 1.5 |
| Trauma | 1.4 |

|  |  |
| --- | --- |
| Causes of cardiac readmissions | % |
| Heart failure | 14.3 |
| Acute myocardial infarction | 13.2 |
| Coronary artery disease including angina | 10.3 |
| Arrhythmias | 6.6 |
| Pericarditis | 0.6 |
| Valve and other cardiac disorders | 2.1 |