THE MISSED OPPORTUNITY OF SAME-DAY DISCHARGE AFTER ELECTIVE PERCUTANEOUS CORONARY INTERVENTION IN THE UNITED STATES.

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KEY POINTS

Question: What is the contemporary US practice of same day discharge (SDD) after elective PCI with respect to the incidence, variation, trends, costs, and safety outcomes?

Findings: Among 672,470 elective PCIs, across 493 US hospitals, over a decade spanning 2006-2015, SDD occurred infrequently (3.5%) with an extreme 382% hospital variation. However, SDD was safe short-and long-term and associated with large savings >$5,000/PCI attributed to reduced supply and room & board costs.

Meaning: Greater and consistent use of SDD could increase overall value in PCI care and save US hospitals ~$577 million if adopted in the US in the bundled payment era.

TWEET

#Same day discharge after elective PCI despite being safe, is still rare with extreme hospital variation. Greater and more consistent use of SDD could increase overall value in PCI care and save US hospitals ~ $577 million if adopted throughout the US in the bundled payment era.

ABSTRACT

Importance: Same day discharge (SDD) after elective percutaneous coronary intervention (PCI) is associated with lower costs, and preferred by patients. However, contemporary patterns of SDD after elective PCI with respect to the incidence, variation, trends, costs, and safety outcomes in the US are unknown.

Objectives: We examined 1) incidence and trends in SDD; 2) hospital variation in SDD; 3) the association between SDD and readmissions for bleeding, acute kidney injury (AKI), acute myocardial infarction (AMI) or mortality at 30-, 90- and 365 days after PCI; 4) hospital costs of SDD and its drivers.

Design: Observational cross-sectional and cohort study.

Setting: Nationally representative Premier Healthcare Database (PHD).

Participants: 672,470 elective PCI patients from 493 hospitals between 1/2006-12/2015 with 1 year follow-up.

Exposures: SDD; defined by identical dates of admission, PCI procedure and discharge.

Main outcomes and measures: Death, bleeding requiring transfusion, AKI and AMI at 30-, 90-, or 365 days after PCI, and costs from hospitals' perspective, inflated to 2016.

Results: Among 672,470 elective PCIs, the adjusted rate of SDD was 3.5% (95%CI 3.0-4.0%), which increased from 0.4% in 2006 to 6.3% in 2015. We observed extreme hospital variation for SDD from 0-83% (median incidence rate ratio (MIRR) 3.82 (95%CI 3.48–4.23), implying an average (median) 382% excess likelihood of SDD at one vs. another random hospital. Among SDD (vs. non-SDD [NSDD]) patients, there was no excess risk of death, bleeding, AKI or AMI at 30-, 90- or 365 days. SDD was associated with large cost savings of $5,128/procedure (95% CI

$5,006–$5,248), driven by reduced supply and room & boarding costs. A shift from existing SDD practice to match top decile SDD hospitals could annually save $129 million in our sample and $577 million if adopted throughout the US. However, residual confounding may be present limiting the precision of the cost estimates.

Conclusions: Over a decade spanning 2006-2015, SDD after elective PCI was infrequent with extreme hospital variation. Given the safety and large savings in excess of $5,000/PCI associated with SDD, greater and more consistent use of SDD could markedly increase overall value in PCI care.

INTRODUCTION

Elective percutaneous coronary intervention (PCI) is common in the United States, performed in ~half of 600,000 PCI procedures annually.[1] With the increasing pressure on hospitals to improve the quality and value of their services, reducing the costs of elective PCI, is an important opportunity to explore. In fact, alternative payment models (APMs), such as the Centers for Medicare and Medicaid Services (CMS) episode payment models (EPMs), commonly known as "bundled payments", are accelerating hospitals to prepare for the shift in reimbursement from 'payment for volume' to 'payment for value'.[2]

Same day discharge (SDD) after elective PCI is a potential strategy for improving the value of PCI as it is associated with greater patient satisfaction, while simultaneously reducing costs.[3-7] Despite observational and randomized data demonstrating safety of SDD, prior studies from 2004-2008 and 2009-2013 suggest relatively modest uptake of this practice in the United States.[8;9] These results are not surprising, as there have been few systematic efforts towards implementing SDD after elective PCI, although emerging payments models may create an urgency to adopt this practice if it is safe and financially beneficial to hospitals. While our prior work has shown the cost savings from SDD can be substantial, a contemporary analysis of the incidence, variation, trends, costs, the source of the cost savings and safety outcomes associated with SDD is needed to define the potential missed opportunity of adopting SDD and for improving the value of PCI. Therefore, we designed this large, nationally representative study with the following objectives: 1) To identify contemporary incidence and temporal trends in SDD after elective PCI; 2) To identify the hospital variation in the practice of SDD after accounting for hospital case-mix; 3) To identify the hospital costs associated with SDD and the sources of cost savings attributable to SDD and 4) To compare the rate of readmissions for bleeding, acute kidney injury (AKI), acute myocardial infarction (AMI) and mortality at 30-, 90- and 365 days after index PCI among SDD and non-SDD (NSDD) patients.

METHODS

Study participants

We used the Premier Healthcare Database (PHD) (https://www.premierinc.com/), which is an administrative claims data representing ~20% of all acute care hospitalizations in the United States for over 15 years and contains socio-demographics, comorbidities, interventional procedures, medications, costs and outcomes based on International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM) codes for diagnoses and procedures as reported by the contributing hospitals. To assess time trends, we included PCI procedures performed in a 10-year period starting January 1, 2006 and ending December 31, 2015. During this period 1,443,297 PCIs were available from which we defined elective PCIs using the CONSORT diagram (Figure 1). To ensure an 'all-comer' elective PCI population, we included: A) patients with a discharge status of 'outpatient'; OR B) patients with a discharge status of 'inpatient' but were admitted as 'elective'; OR C) patients admitted directly from home, clinic, primary care or referred by a health maintenance organization (HMO) without an admission diagnosis of an acute coronary syndrome, but who were admitted as 'non-elective', and discharged as 'inpatient'. Lastly, we also recognized that a small number of patients with chest pain or unstable angina are occasionally directly referred from clinics or an emergency room (ER) visit for an elective cardiac catheterization and ad-hoc PCI. Therefore, we also included patients marked as 'elective' status on admission and referred with an admission diagnosis of unstable angina from one of the following sources: home, clinic, primary care or referred by a HMO or ER and 'inpatients' at discharge (D). We believe these inclusions allow capture of the full spectrum of 'real-world, all-comer' elective PCI patients in the US.

Same day discharge

SDD was identified when the date of admission, date of PCI procedure and date of discharge were identical. Based on this, patients were categorized into two groups – those who underwent SDD and those who did not (NSDD).

Study outcomes, comorbid conditions and confounders

Information on death, bleeding requiring transfusion, AKI and AMI following discharge after the index PCI was available at three time points: 30-, 90- and 365 days from the date of PCI. The follow-up information (within 30-, 90- and 365 days) was limited to survivors from the index hospitalization and therefore excluded deaths during the index hospitalization. Moreover, we included information on the following potential site-level and patient-level confounders: number of beds in the hospital, hospital teaching status, hospital location; primary payer, socio-demographics, procedural characteristics, and prior history of 24 co-morbidities (Table 1).

Costs

Premier uses a micro-costing approach to report department-wise and total costs related to PCI and hospitalization. Costs were reported as total fixed, total variable and total costs. We adjusted the costs for inflation using the medical consumer price index[10] inflation rates at the end of the year 2016.

Statistical analyses

Descriptive statistics included means (±SD) or medians for continuous variables and frequencies (percentage) for categorical variables, as appropriate. In all multivariable analyses, we used hierarchical, mixed-effects regression models with hospital as the random effect. This strategy not only allowed a more robust estimation of the standard errors but also permitted an assessment of the across-hospital variation. Incidence was estimated using mixed-effects Poisson regression models. Time trends were assessed using regression models with calendar year as a covariate. The association of SDD with the study outcomes was determined using mixed-effects logistic regression models and cost differences associated with SDD were determined using mixed-effects linear regression. Inter-hospital variation was quantified as follows: from linear regression models we estimated the intra-class correlation coefficient (ICC) as the contribution of the hospital-level variance to the overall variance[11]; from Poisson regression models we estimated the median incidence rate ratio (MIRR) using the methods of Larsen and Merlo[12] and Rabe-Hesketh and Skrondal[13]. The MIRR quantifies the average (median) likelihood that a statistically identical patient presenting at one random hospital vs. another would undergo SDD. If the MIRR is equal to one, there would be no differences between hospitals in the likelihood of undergoing SDD. Confidence intervals around the MIRR were generated to quantitatively define the significance of the variation in SDD across hospitals.[12]

To ensure that the association of SDD with outcomes and costs was robust, we conducted propensity score matching analyses. A multivariable, propensity score was generated using a single nearest-neighbor matching method. This propensity score model predicting SDD, adjusted for confounders of age, female gender, Medicare/Medicaid, number of hospital beds, teaching hospital, urban hospital, history of diabetes, hypertension, COPD, peripheral arterial disease, cerebrovascular disease, acute myocardial infarction, prior CABG, prior PCI, current heart failure, shock, cardiac arrest, multi-vessel disease, IABP used, bare metal stent used, atherectomy performed, bifurcation lesion PCI, and chronic total occlusion PCI. Variable-level balance before and after matching was examined using standardized difference of means, where a difference of <10% is considered good balance, while model-level balance was examined using the Rubin's B and Rubin's R statistics.[14] All association analyses of the association of SDD with outcomes used the propensity score as a covariate in hierarchical models. Finally, to ensure that our observations and inferences were not influence by likely confounders, we conducted three additional sets of sensitivity analyses. We repeated all analyses by excluding 1) low PCI volume hospitals (<50 PCIs/year); 2) transradial PCI; and 3) 'High-cost' patients who either decompensated during their PCI requiring hemodynamic support with Impella or IABP, mechanical ventilation or requiring rotational-, orbital- or LASER atherectomy. All statistical analyses were conducted using Stata 12.0 (Stata Corp., College Station, TX). We used the user-defined programs xtmrho[15] to quantify inter-hospital variation and psmatch2[16] for the propensity score analyses. Significance was tested at a 2-sided type-1 error rate of 0.05.

RESULTS

Study participants

From 1,443,297 PCIs, we included 672,470 (46.58%) elective PCI patients from 493 US hospitals (Figure 1). A total of 62,920 (9.1%) patients underwent SDD. Amongst those undergoing radial access, the rate of SDD was also quite low; ~1 in 5 (20.6%) elective radial PCI patients underwent SDD. The patient characteristics by SDD are detailed in Table 1. Briefly, the mean age was 65.5 years, 67% were males and 73.1% were white. Most hospitals (40.0%) had 500 or more beds; 92.1% were urban and 49.5% were teaching hospitals. Medicare/Medicaid accounted for 59.9% of admissions. Bare metal stents (BMS) were used in 16.5% of the cases, while 20% of cases were for multiple vessels. A small proportion of elective PCI patients decompensated during the procedure requiring hemodynamic support with Impella or IABP, or mechanical ventilation or requiring rotational-, orbital- or LASER atherectomy (all < 1%). Hospitals with <100 beds and use of transradial access were associated with a crude SDD rate exceeding 20% while the use of low molecular weight heparin and G2B3A, and hospitals with 100-199 beds were associated with crude SDD rates below 5% (Table 1).

Incidence, Trends and Variation in SDD across Hospitals

Figure 2A shows the annual rate of SDD in elective PCIs estimated using mixed effects Poisson regression with hospital as a random effect. The unadjusted, overall SDD rate (9.1%) was corrected to 3.5% (95% CI 3.0%-4.0%) after accounting for the significant inter-hospital variation, suggesting that the higher unadjusted rate is attributable to a few larger centers performing a larger number of SDD procedures, while the vast majority of smaller centers had lower rates of SDD. The MIRR was 3.82 (95% CI 3.48–4.23) implying that on average (median) a patient with identical clinical profile was 382% more likely to undergo SDD at one hospital vs. another random hospital in our sample. We observed that the adjusted incidence steadily increased from 0.4% in 2006 to 6.3% in 2015, corresponding to a 19% annual increase over time which was significant (P for trend <0.001) (Figure 2A, inset). Also, transradial access was significantly associated with a higher likelihood of SDD (IRR 1.45, 95% CI 1.40–1.50, p<0.001). We observed marked variation in SDD rate ranging from 0%-83% (Figure 2B). Over time, the MIRR declined from 6.66 in 2006 to 3.57 in 2015 (Figure 2B inset). Despite reductions over time, the variability across hospitals remained very large in 2015 (MIRR 3.57, 95% CI 3.18–4.04).

Association of SDD with outcomes

In a series of mixed effects, hierarchical, logistic regression models, we examined the association of SDD with each study outcome – first without propensity adjustment and then after adjusting for the propensity score (Table 2). From these results, we observed that SDD was not associated with a higher rate of rehospitalization for bleeding, AKI, AMI or mortality after discharge.

Association of SDD with hospital costs

Next, we determined the association of SDD with hospital costs and their components. Figure 3A shows that SDD was associated significantly with reduced fixed, variable and total costs. The total hospital costs were \$5,128 (95% CI \$5,006–\$5,248) less in SDD patients as compared to NSDD patients even after accounting for the inter-hospital variation in case-mix and the propensity score (filled green bar in Figure 3A). We next divided our cohort into two groups of a) top-decile SDD hospitals (median SDD rate 44.5%, N = 75,694) and b) non-top decile SDD hospitals (median SDD rate 2.2%, N = 596,776). If the non-top decile hospitals increased their SDD rate from a median of 2.2% to match the top-decile SDD hospitals' SDD rate of 44.5%, we estimated annual savings would be \$129 million across Premier hospitals and \$433,828 annually for an average hospital performing 200 elective PCIs annually. With 300,000 elective PCIs in the US annually, and assuming a shift in practice from 2.2% SDD to 44.5% SDD amongst the non-top decile hospitals (where 88.74% PCIs performed), the projected cost savings would be approximately $577 million annually. Assuming a more conservative shift from 22.3% SDD (BJH NCDR CathPCI institutional report, quarter 4, 2017) to 44.5% SDD the projected cost savings would still be substantial at $341 million annually. Interestingly, the rates of adverse outcomes after SDD in top SDD decile hospitals compared to the remaining hospitals were not significantly different (Supplementary Figure 2) supporting the conjecture that the above-mentioned shift in practice may be achieved without additional burden of adverse outcomes. Finally, when we investigated the department-wise components of costs, we found that the major drivers of the reduced costs were central supply, and room and board costs (Figure 3B).

Sensitivity analyses

To ensure that results were not swayed by confounders, we conducted three additional sensitivity analyses. First, low PCI volume hospitals (<50 PCIs per year) could impact the variation in SDD rates across hospitals. After excluding low-PCI-volume hospitals the adjusted SDD rate remained unchanged at 3.50% (95% CI 2.97–4.12) with a highly significant and unchanged inter-hospital variation in SDD rate (MIRR 3.84, 95% CI 3.44–4.33) (Supplementary Table 1).

Second, since transradial PCI is associated with reduced costs and better outcomes and patients with transfemoral access were less likely to undergo SDD (8.6%) vs transradial PCI (20.6%), we excluded transradial PCI and examined if costs and outcomes associated with SDD amongst the subset of transfemoral PCI were influenced by this exclusion. In patients undergoing transfemoral PCIs (n=646,182), associations between SDD and the study outcomes were unchanged from the overall analyses (Supplementary Table 2) but slightly lower (but statistically non-significant) adjusted cost savings of $5,095, 95% CI ($4,966-$5,224) in transfemoral PCI patients, than the overall cost savings of $5,128 (95% CI $5,006–$5,248).

Third, the association of SDD with costs could have been skewed by high cost patients who decompensated during PCI requiring hemodynamic support, mechanical ventilation or atherectomy. Excluding these patients (n=7,909, 1.2% of the entire cohort) did not significantly influence the cost savings (Supplementary Table 3). After excluding these patients, the total cost savings associated with SDD were reduced to $4,813 (95% CI $4,714-$4,912) in all hospitals and to $4,790 (95% CI $4,690-$4,891) in high-PCI volume (≥50) hospitals.

Together, our sensitivity analyses demonstrate the study findings are unlikely to have been confounded by hospital PCI volume, transradial access and patients who decompensated requiring hemodynamic support, mechanical ventilation or atherectomy.

DISCUSSION

As hospitals face increasing pressure to provide safe and effective healthcare at lower cost, SDD has been touted as one strategy to improve the value of PCI.[17] To the best of our knowledge this is the *first and only* study of contemporary SDD practice in the United States which builds upon prior studies of SDD with three novel observations. First, not only was the rate of SDD low with a weakly increasing trend; there was extreme variation in the practice of SDD across US hospitals, indicating that SDD practices in the US are essentially random, likely driven by local culture rather than evidence-based practice. Second, in this era of bundled payments, our study highlights both the economic opportunity of SDD and the source of the cost savings. The costs savings attributable to SDD were large in excess of $5,000/case and driven by reducing central supply and room & board costs. Third, SDD was safe after discharge. Not only were the 30-, 90- and 365-day adverse outcomes similar for SDD vs. NSDD patients, but these outcomes were also similar amongst patients undergoing SDD at top-decile hospitals vs. other hospitals, indicating the sustained safety of SDD across time points and supporting the conjecture that a shift in practice may be achieved without additional burden of adverse outcomes.

Our study and prior studies[8] indicate that while SDD is increasing perhaps due to greater adoption of radial access, SDD is still performed only in a minority of elective PCI patients, the magnitude of the increase has been modest and the room for improvement is substantial. While a radial approach facilitates SDD, there are cases in which the femoral access remains the procedural of choice. In a recent study from BJH hospital, St. Louis, MO, in which we observed cost savings of ~$7,000/case of SDD, more than half of the SDD patients actually underwent femoral access, using 85% vascular closure devices (VCDs).[17] In the present study too, SDD after femoral access resulted in slightly lower, but still substantial cost savings of $5,095/case.

A unique aspect of Premier is that the costs reflect actual resource use costs obtained directly from each hospital's financial department. The cost savings associated with SDD were large exceeding $5,000/case, due to supply and room & board costs averted. Increasing SDD from existing low rates to even modestly higher rates could result in a large savings for hospitals and adoption of SDD could be an important strategy for hospitals participating in CMS's, Bundled Payments for Care Improvement Advanced (BPCI Advanced).[2]

It is unclear if archaic hospital policies, physician inertia or concerns regarding patient safety limit the uptake of SDD after elective PCI. While complications are generally rare after elective PCI, when they do occur, they usually do so in the first few hours after PCI, facilitating the identification of patients who are unsafe for SDD.[3;4;8;19-21] The practice of overnight observation for all patients after elective PCI for the concern for patient safety is not founded in evidence. Several randomized trials have confirmed the safety of SDD vs. NSDD.[5;6;22] A meta-analysis of 30 observational studies and 7 randomized control trials validated comparable safety of SDD and NSDD.[6] Our study too did not find any excess risk of short- nor long-term outcomes such as bleeding, AKI, AMI or death among patients undergoing SDD vs. NSDD groups. Even more powerful is the signal of sustained safety in the 44.5% patients undergoing SDD at top-decile hospitals who had no excess 30-, 90- and 365 day adverse outcomes than the 2.2% SDD patients at non-top decile SDD hospitals.

We found marked variation with an excess of 300% variation in the likelihood of SDD across hospitals. This degree of variation suggests that hospitals' practices for SDD are essentially random, not explained by patient characteristics nor case mix and implies that a) some hospitals are more comfortable than others in performing SDD and b) the evidence base for SDD is not strong, hence SDD practices across hospitals are cultural rather than evidence based. In a recent study from Barnes Jewish Hospital, St Louis MO we found that developing a 'patient-centered' protocol for SDD based on patients' predicted risks of complications such as bleeding and AKI led to rapid adoption of SDD in >70% of elective PCI patients and was associated with $1.8 million cost savings annually in hospitalization costs.[17]

Limitations

Our study should be interpreted in the context of several limitations. First, our data until 2015 are lagging behind the current practice by 3 years. More contemporary NCDR CathPCI registry institutional reports show a substantially higher rate of SDD (22.3% in the last quarter of 2017). Notwithstanding this, increasing the SDD rate from 22.3% to the top decile rate of 44.5% would still represent substantial cost savings (estimated $341 million). However, it should be noted that the 22.3% unadjusted SDD rate in the CathPCI registry (or 16.96% in 2015 in Premier) does not account for the extreme inter-hospital variation and the resulting cost savings would be underestimated, assuming a similar pattern of inter-hospital variation in CathPCI. Second, angiographic details and procedural complexity are not captured in our data and the potential for unmeasured confounding remains. Third, outcomes such as bleeding, AKI and mortality have been ascertained via ICD-9 codes, which could result in misclassification of outcomes. Fourth, the cost savings associated with SDD in the study are direct resource use costs from a hospitals' perspective. They do not capture the opportunity costs and underestimate the true cost savings. Fifth, our elective population included a small proportion of patients with unstable angina, those decompensating during PCI, requiring hemodynamic support or atherectomy or mechanical ventilation. Their inclusion does not imply they are eligible for SDD; rather, their inclusion is important to capture the full spectrum of 'real-world, all-comer' elective PCI population in the US. Sixth, the association of SDD with 30-,90- and 365-day outcomes may have a strong likelihood of confounding by indication. Nonetheless, the raw rates of events are still instructive, since they are very low, it appears that SDD in the patients selected doesn't appear to compromise safety. Seven, as exact time stamps of PCI and discharge were unavailable, we were unable to identify the patients treated late in the day, that otherwise would have been eligible for SDD but were kept overnight in view of the late hour. Eight, this study is unable to identify the specific criteria different hospitals chose for SDD, nor their angiographic nor PCI characteristics. Lastly, based on the association between transradial access and SDD, it should be mentioned that the rising trend in SDD may, in part, be contributed by an increasing trend in the practice of transradial access.

Conclusions

In this large, contemporary and nationally representative study of SDD practices in the United States, we found that in the decade spanning 2006-2015, despite reduced costs and sustained safety, SDD was used in a minority of patients; and variation in the practice of SDD among hospitals was marked. Given the safety and large savings exceeding $5,000/per case, greater and more consistent use of SDD could increase the value of PCI and save US hospitals ~$577 million. Taken together, our findings underscore a potentially large missed opportunity of SDD in the United States.

TABLES

Table 1: Characteristics of the patients included in the study (n = 672,470)

Characteristic	**SDD (n=60,920)**		**NSDD (n=611,550)**		**SDD Rate (%)**
	N	**%**	**N**	**%**	
Hospital characteristics					
Total number of beds at hospital					
000-099	1615	2.65	6161	1.01	20.77
100-199	2228	3.66	45740	7.48	4.64
200-299	7924	13.01	79188	12.95	9.10
300-399	12374	20.31	129,119	21.11	8.75
400-499	8015	13.16	110,995	18.15	6.73
500+	28764	47.22	240,347	39.30	10.69
Hospital Teaching					
No	29943	49.15	309,533	50.61	8.82
Yes	30977	50.85	302,017	49.39	9.30
Hospital - Urban/Rural					
Rural	3608	5.92	49,482	8.09	6.80
Urban	57312	94.08	562068	91.91	9.25
Patient and hospitalization characteristics					
Age*	65.30	10.80	65.55	11.42	---
Female gender	17775	29.18	204222	33.39	8.01
Marital Status 'Married'	34492	56.62	341992	55.92	9.16
Hispanic ethnicity	4070	6.68	26641	4.36	13.25
Race					
Black	3790	6.22	48171	7.88	7.29
Other	11074	18.18	103544	16.93	9.66
Unknown	96	0.16	579	0.09	14.22
White	44457	72.98	447366	73.15	9.04
Insurance Payer					
Medicare – traditional	24627	40.43	265433	43.40	8.49
Managed care	17040	27.97	151239	24.73	10.13
Medicare – Managed Care	7995	13.12	68835	11.26	10.41
Commercial – Indemnity	3757	6.17	38607	6.31	8.87
Medicaid – Traditional	1547	2.54	19214	3.14	7.45
Self-pay	890	1.46	16335	2.67	5.17
Prior history					

Diabetes	24289	39.87	256479	41.94	8.65
Dyslipidemia	49102	80.60	504439	82.49	8.87
Hypertension	50628	83.11	522231	85.39	8.84
Smoking	27536	45.20	268956	43.98	9.29
Congestive Heart Failure	8915	14.63	118726	19.41	6.98
Prior history of PCI	58893	96.67	607119	99.28	8.84
Prior history of CABG	2475	4.06	20294	3.32	10.87
Prior History of AMI	7944	13.04	84123	13.76	8.63
Prior History of TIA	1175	1.93	12227	2.00	8.77
Prior History of Hemorrhagic Stroke	4496	7.38	45049	7.37	9.07
Prior History of Ischemic Stroke	1115	1.83	12483	2.04	8.20
Acute Renal Failure	3128	5.13	48100	7.87	6.11
Chronic Renal Disease	6086	9.99	86072	14.07	6.60
Atrial Fibrillation	6502	10.67	80425	13.15	7.48
COPD	9118	14.97	109778	17.95	7.67
Alcohol Abuse	475	0.78	6818	1.11	6.51
Drug Abuse	269	0.44	3950	0.65	6.38
Prior History of Any type of Cancer	6965	11.43	74639	12.20	8.54
Prior history of Heart Transplant	1	0.00	25	0.00	3.85
Medications during index PCI					
IV Heparin given on day of PCI	6	0.01	50	0.01	10.71
LMWH given on day of PCI	1037	1.70	86985	14.22	1.18
Any G2B3A given on day of PCI	6339	10.41	123589	20.21	4.88
PCI characteristics					
Drug-eluting stent used	44961	73.80	476717	77.95	8.62
Bare metal stents used	8116	13.32	102891	16.82	7.31
Radial access	5424	8.90	20864	3.41	20.63
Bifurcation during PCI	1035	1.70	15177	2.48	6.38
FFR during PCI	3477	5.71	17116	2.80	16.88
IVUS used	7012	11.51	59405	9.71	10.56
Rotational atherectomy	57	0.09	435	0.07	11.59
LASER atherectomy	972	1.60	6714	1.10	12.65

*Columns show mean and standard deviation and not N and %.

Table 2: Short- and long-term outcomes after same day discharge.

	Incidence*		Strength of Association**	
Outcome	**SDD Incidence (95% CI)**	**NSDD Incidence (95% CI)**	**Unadjusted OR (95% CI), p**	**Propensity adjusted OR (95% CI), p**
At 30 days				
Death	0.29 (0.14 - 0.63)	1.82 (1.68 - 1.98)	0.26 (0.18 - 0.37), <0.0001	0.33 (0.23 - 0.47), <0.0001
Transfusion for bleeding	4.23 (3.51 - 5.11)	6.90 (6.25 - 7.61)	0.46 (0.40 - 0.52), <0.0001	0.53 (0.46 - 0.60), <0.0001
Acute kidney injury	5.14 (4.39 - 6.02)	9.94 (9.40 - 10.52)	0.44 (0.39 - 0.50), <0.0001	0.53 (0.47 - 0.59), <0.0001
Acute myocardial infarction	4.74 (4.01 - 5.61)	7.59 (7.13 - 8.08)	0.56 (0.49 - 0.63), <0.0001	0.62 (0.54 - 0.70), <0.0001
At 90 days				
Death	1.60 (1.20 - 2.12)	3.99 (3.74 - 4.26)	0.39 (0.32 - 0.48), <0.0001	0.48 (0.39 - 0.59), <0.0001
Transfusion for bleeding	8.91 (7.58 - 10.48)	14.02 (12.71 - 15.47)	0.48 (0.44 - 0.53), <0.0001	0.56 (0.51 - 0.61), <0.0001
Acute kidney injury	11.20 (9.87 - 12.72)	20.21 (19.21 - 21.27)	0.51 (0.47 - 0.55), <0.0001	0.60 (0.55 - 0.65), <0.0001
Acute myocardial infarction	9.31 (8.18 - 10.59)	14.49 (13.76 - 15.27)	0.58 (0.53 - 0.64), <0.0001	0.65 (0.59 - 0.71), <0.0001
At 1 year				
Death	5.39 (4.63 - 6.28)	10.74 (10.17 - 11.33)	0.45 (0.40 - 0.51), <0.0001	0.54 (0.48 - 0.61), <0.0001
Transfusion for bleeding	21.10 (18.57 - 23.98)	30.66 (27.88 - 33.71)	0.55 (0.52 - 0.58), <0.0001	0.63 (0.59 - 0.66), <0.0001
Acute kidney injury	30.61 (27.96 - 33.50)	49.35 (47.03 - 51.79)	0.57 (0.54 - 0.60), <0.0001	0.66 (0.63 - 0.70), <0.0001
Acute myocardial infarction	23.17 (21.17 - 25.35)	33.31 (31.86 - 34.82)	0.64 (0.60 - 0.68), <0.0001	0.70 (0.66 - 0.74), <0.0001

*Incidence rates are shown per 1000 PCIs and are estimated using hierarchical, mixed effects Poisson regression model that used hospitals as the random effects.

** All results are from hierarchical logistic regression models that used hospital site as the random effect.

OR, odds ratio; CI, confidence interval; SDD, same day discharge; NSDD, not same day discharge; CI, confidence interval.

FIGURE LEGENDS

Figure 1: Flowchart to identify elective PCI population in Premier.

PCI – percutaneous coronary intervention, ACS – acute coronary syndrome, ER – emergency room, UA – unstable angina.

Figure 2: Temporal trends (panel A) and hospital variation (panel B) in the practice of SDD after elective PCI in the United States.

Inset A shows a magnified, scaled graph of the temporal trend for SDD, with a regression coefficient of 1.19, implying an increase of 19% annually over the base line rate in 2006.

Panel B shows a bubble plot of the rate of SDD by hospitals performing >50 PCIs annually. Size of bubbles is proportionate to hospitals' annual PCI volume.

Inset B shows the temporal trend in the median incidence rate ratio (MIRR) for SDD for hospitals across the study years, implying a substantial but decreasing variation in SDD practices across hospitals**.**

Figure 3: Cost savings associated with SDD (panel A) and drivers of cost savings attributable to SDD (panel B).

ICU – intensive care unit, EKG – electrocardiogram, U – unadjusted, A – adjusted. ICC – intraclass correlation coefficient.

FIGURES

Figure 1: Flowchart to identify elective PCI population in Premier.

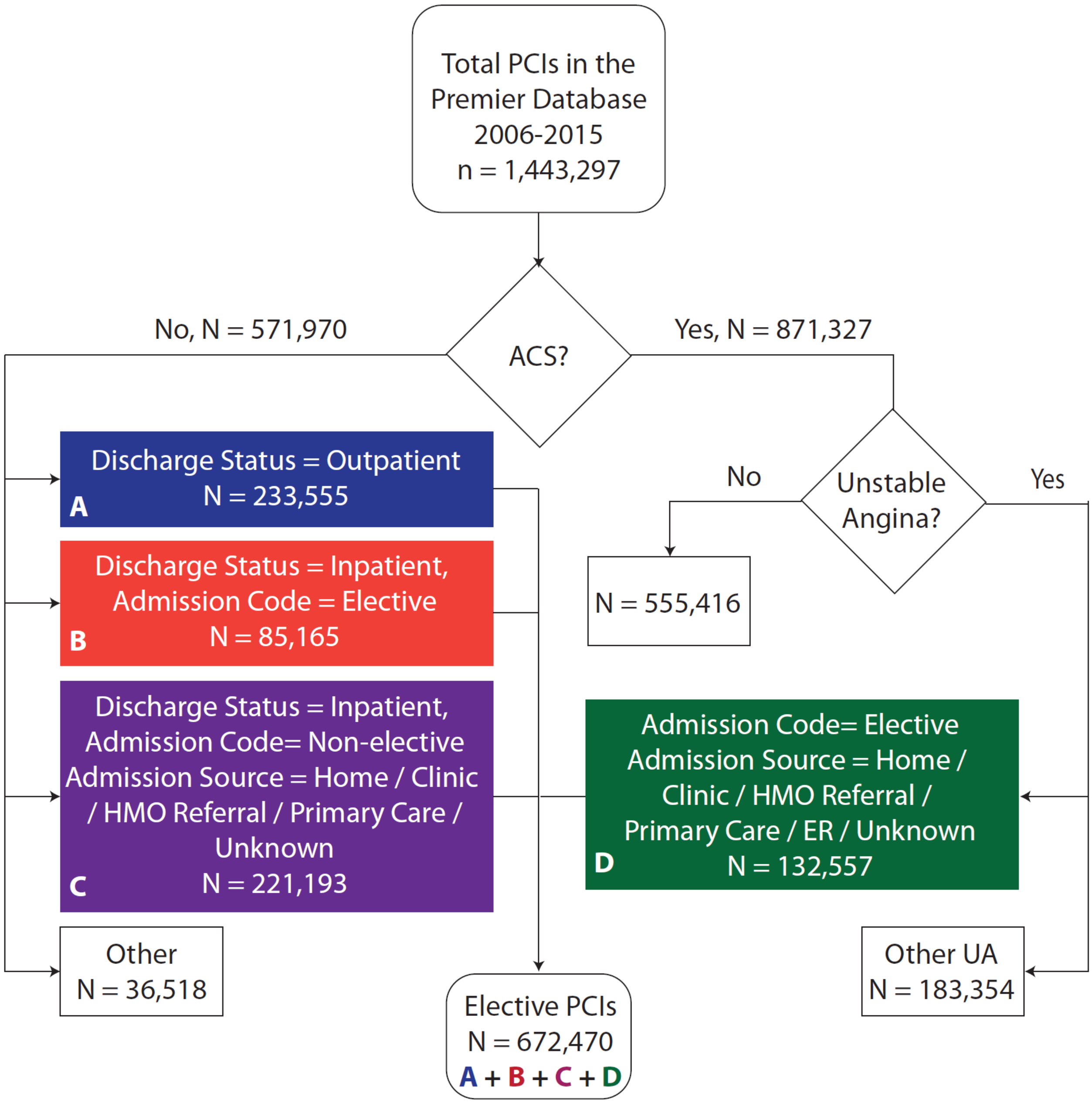


Figure 2: Temporal trends (panel A) and hospital variation (panel B) in the practice of SDD after elective PCI in the United States.

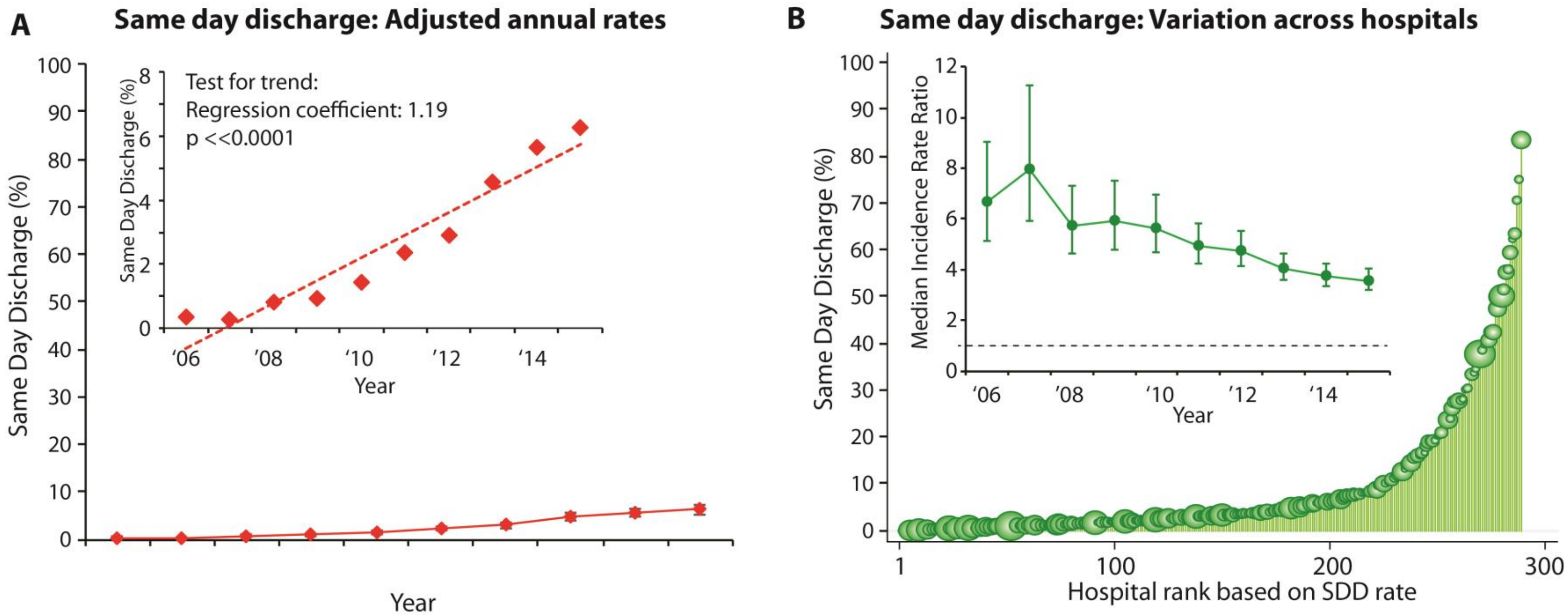
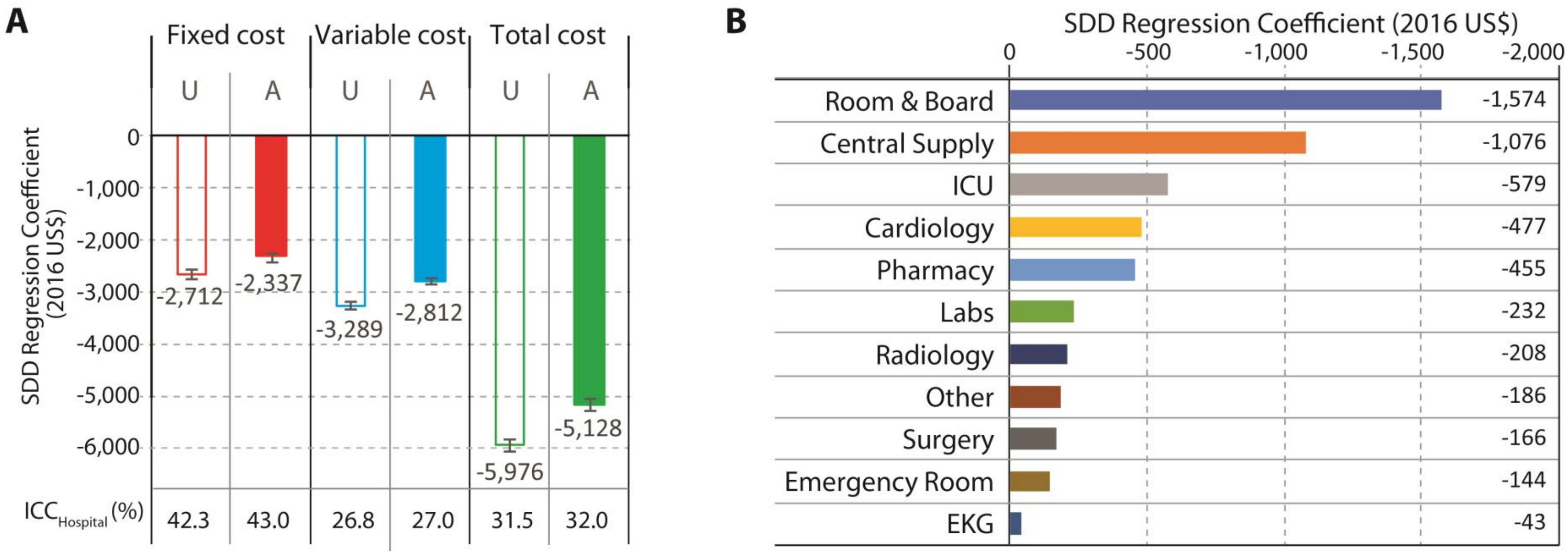


Figure 3: Cost savings associated with SDD (panel A) and drivers of cost savings attributable to SDD (panel B).



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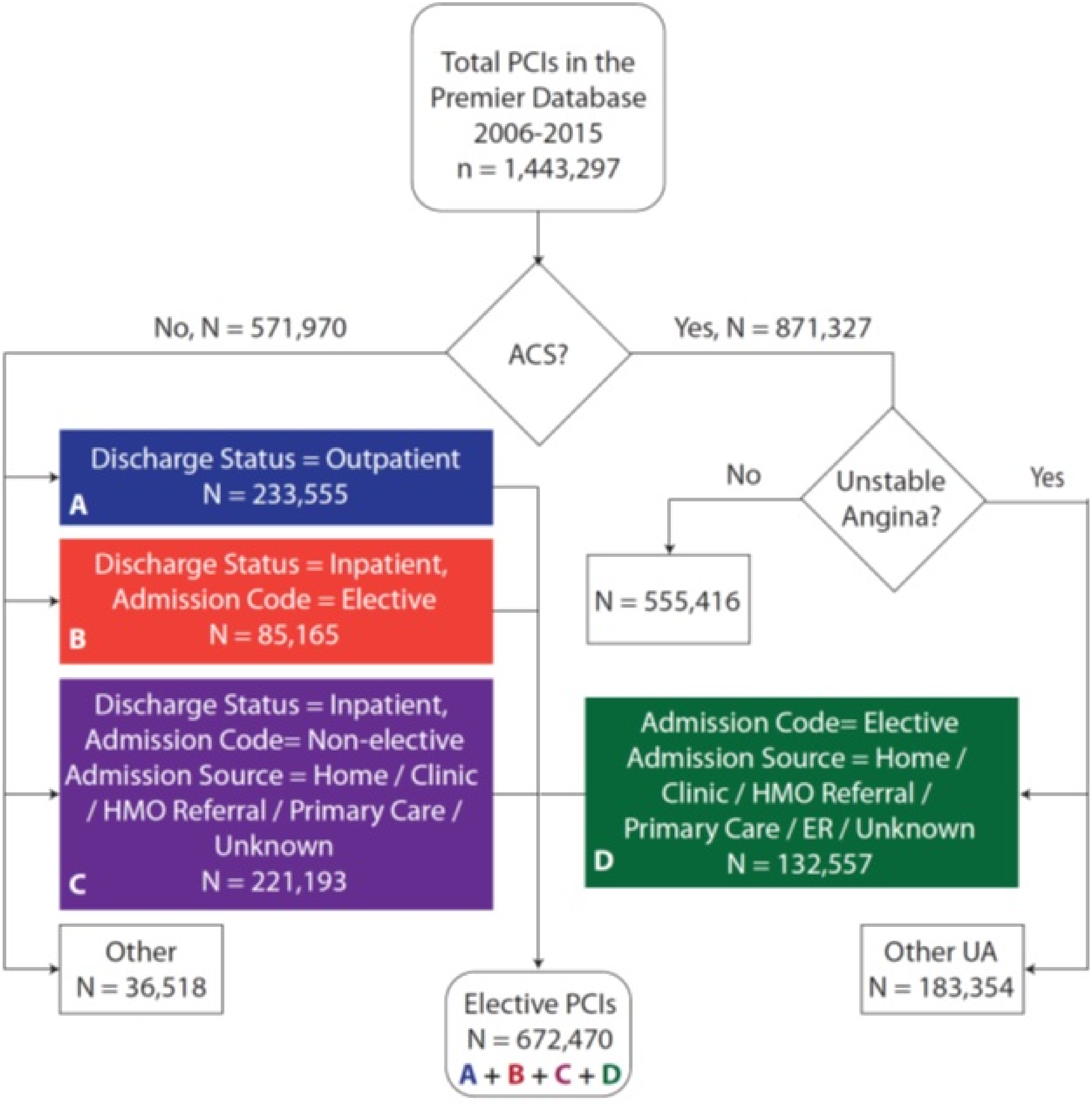
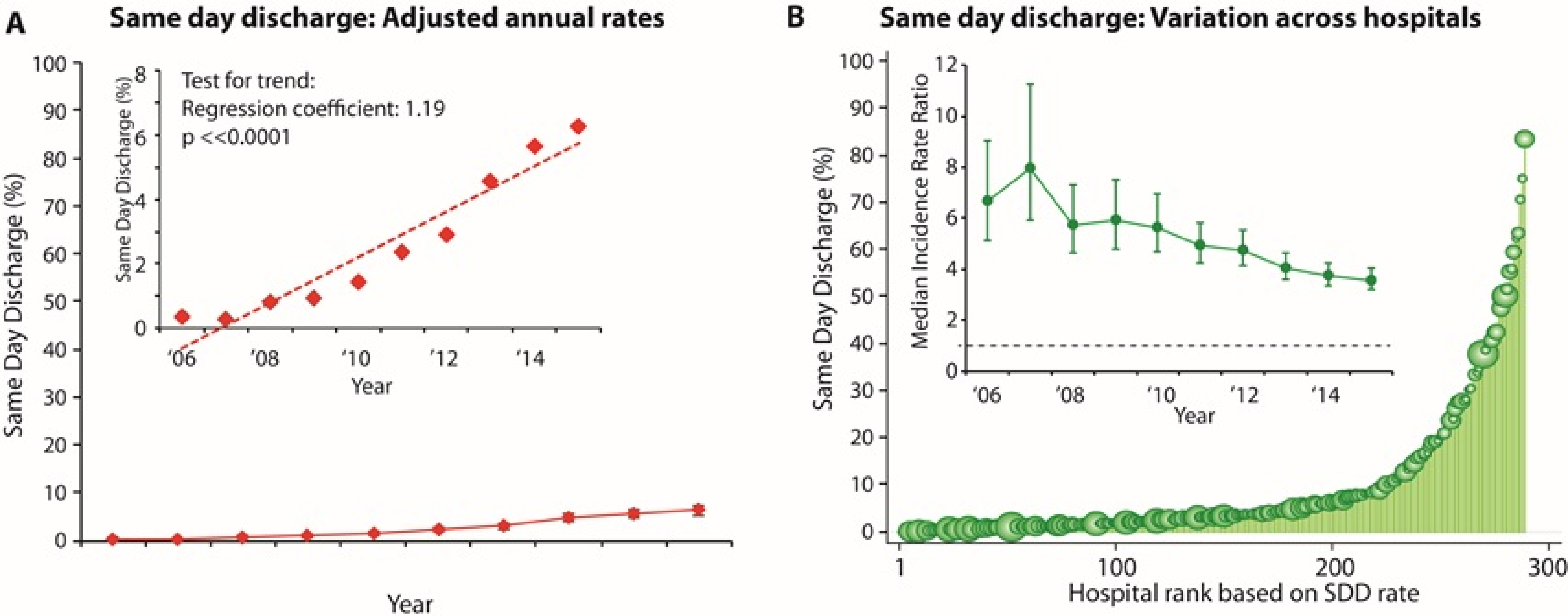
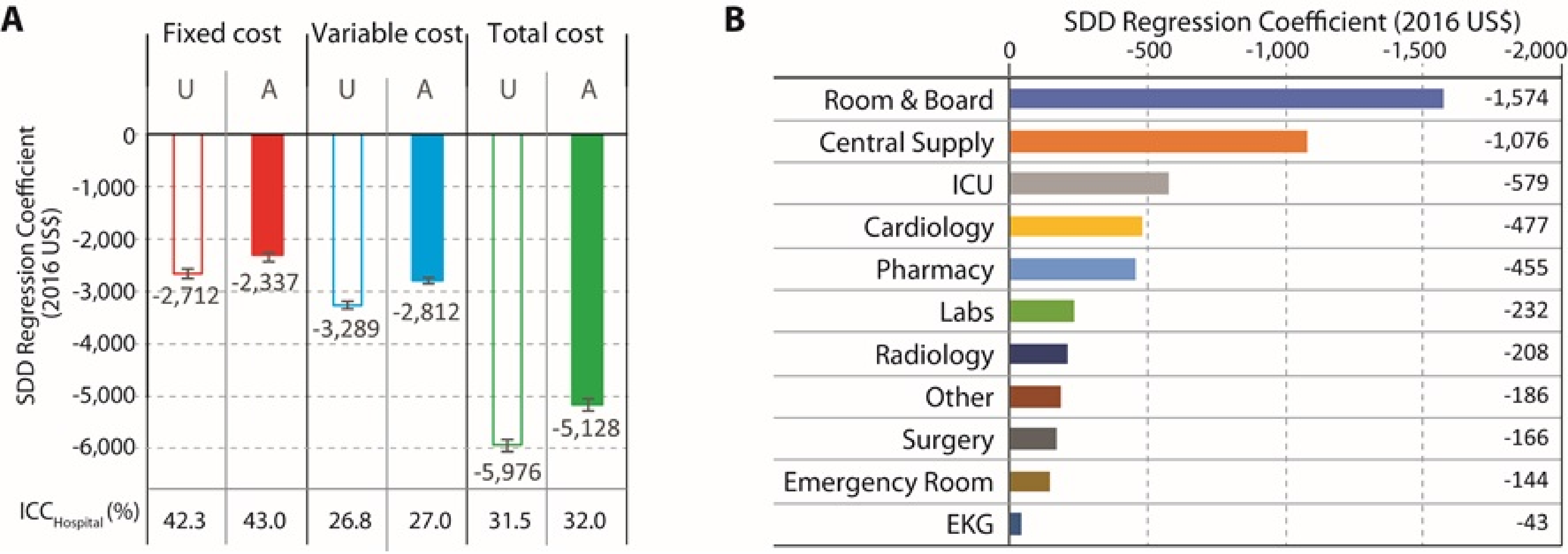

Total PCIs in the Premier Database 2006-2015 n = 1,443,297
ACS?
No, N = 571,970
Yes, N = 871,327
Discharge Status = Outpatient N = 233,555
A
Discharge Status = Inpatient, Admission Code = Elective N = 85,165
B
Discharge Status = Inpatient, Admission Code= Non-elective Admission Source = Home / Clinic / HMO Referral / Primary Care / Unknown N = 221,193
C
Other N = 36,518
Unstable Angina?
No
Yes
N = 555,416
Admission Code= Elective Admission Source = Home / Clinic / HMO Referral / Primary Care / ER / Unknown N = 132,557
D
Other UA N = 183,354
Elective PCIs N = 672,470
A + B + C + D



A
Same day discharge: Adjusted annual rates
Same Day Discharge (%)
Year
Test for trend:
Regression coefficient: 1.19
p <<0.0001
Same Day Discharge (%)
'06
'08
'10
'12
'14
Year
B
Same day discharge: Variation across hospitals
Same Day Discharge (%)
Median Incidence Rate Ratio
'06
'08
'10
'12
'14
Year
Hospital rank based on SDD rate


A
Fixed cost
Variable cost
Total cost
U
A
U
A
U
A
SDD Regression Coefficient (2016 US$)
0
-1,000
-2,000
-3,000
-4,000
-5,000
-6,000
-2,712
-2,337
-3,289
-2,812
-5,976
-5,128
ICC Hospital (%)
42.3
43.0
26.8
27.0
31.5
32.0
B
SDD Regression Coefficient (2016 US$)
0
-500
-1,000
-1,500
-2,000
Room & Board
-1,574
Central Supply
-1,076
ICU
-579
Cardiology
-477
Pharmacy
-455
Labs
-232
Radiology
-208
Other
-186
Surgery
-166
Emergency Room
-144
EKG
-43