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Discharge Against Medical Advice After Percutaneous Coronary Intervention in the United States

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ABSTRACT

OBJECTIVES This study aimed to evaluate discharge against medical advice (DAMA) in percutaneous coronary intervention (PCI) and how DAMA affects readmissions.

BACKGROUND DAMA is infrequent but associated with poor patient outcomes. DAMA in the context of PCI has not been described in the published reports.

METHODS The authors analyzed patients in the Nationwide Readmission Database between 2010 and 2014 with a PCI procedure who were either discharged home or against medical advice. The primary endpoint was all-cause 30-day readmissions and their causes. Descriptive statistics were used to compare DAMA with patients discharged home, and multiple logistic regressions were used to determine patient characteristics associated with DAMA and readmission.

RESULTS Among the 2,021,104 patients in the analysis, the proportion of patients who DAMA was 0.5% (n = 10,049). The 30-day readmission rate for patients who were DAMA and those discharged home was 16.8% and 8.5%, respectively ($p < 0.001$). Important predictors of DAMA included diagnosis of acute myocardial infarction (odds ratio [OR]: 1.37; 95% confidence interval [CI]: 1.25 to 1.51; $p < 0.001$), smoking (OR: 1.71; 95% CI: 1.57 to 1.86; $p < 0.001$), drug abuse (OR: 1.82; 95% CI: 1.60 to 2.06; $p < 0.001$), and alcohol misuse (OR: 1.53; 95% CI: 1.32 to 1.78; $p < 0.001$). DAMA was the strongest predictor for readmission (OR: 1.89; 95% CI: 1.71 to 2.08; $p < 0.001$). DAMA patients were more likely to have neuropsychiatric reasons for noncardiac causes of readmission (8.3% vs. 2.4%) and acute myocardial infarction for cardiac causes of readmission (39.4% vs. 19.5%) compared with patients discharged home.

CONCLUSIONS DAMA occurs in approximately 0.5% of patients following PCI and is strongly associated with readmission within 30 days. Interventions should be developed to reduce DAMA in high-risk groups and initiate interventions to avoid complications and readmission when it occurs. (J Am Coll Cardiol Intv 2018;11:1354–64)

Discharge against medical advice (DAMA) refers to patients who leave the hospital before the treating physician's recommendation for discharge. It poses a problem for physicians treating hospitalized patients and has been noted to occur in 1% to 2% of all medical admissions (1). Some groups within the general population, such as those with mental health problems, are more likely to DAMA (2). Other factors that predict DAMA include self-financing health care, having Medicaid

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insurance, and being young and male (2). Because patients who DAMA have been shown to be at higher risk of adverse outcomes, it has been suggested that these patients should be targeted for post-discharge interventions (3).

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Historically, the published reports related to DAMA originated from cohorts with psychiatric illnesses (4) and substance misuse (5). A variety of factors precipitate DAMA, including problems related to their illness such as substance-seeking behavior or other factors such as financial problems, family pressure on returning home, and dissatisfaction with the hospital routine and treatment (6). DAMA is commonly seen in emergency departments and is associated with higher likelihood of worse outcomes and medicolegal consequences. There is a growing body of published reports suggesting that patients with cardiac problems also choose to DAMA (7–9). No previous study has evaluated DAMA in patients who undergo percutaneous coronary intervention (PCI). In this study, we examine rates, trends, and predictors of DAMA, and evaluate causes of and rates of readmission for patients who DAMA compared with those with discharge home in the Nationwide Readmission Database (NRD).

ABBREVIATIONS AND ACRONYMS

CI = confidence interval

DAMA = discharge against medical advice

DAPT = dual antiplatelet therapy

MI = myocardial infarction

NRD = Nationwide Readmission Database

OR = odds ratio

PCI = percutaneous coronary intervention

METHODS

A full description of the methods is available in the Online Appendix.

STUDY DESIGN AND PARTICIPANTS. The NRD is a publicly available database of all-payer hospital inpatient stays, which was developed by the Agency for Healthcare Research and Quality as a part of the Healthcare Cost and Utilization Project in the United States. The data are drawn from 21 states that are geographically dispersed, and account for approximately 49% of the total U.S. resident population and approximately 49% of hospitalizations.

FIGURE 1 Flow Diagram of Participants

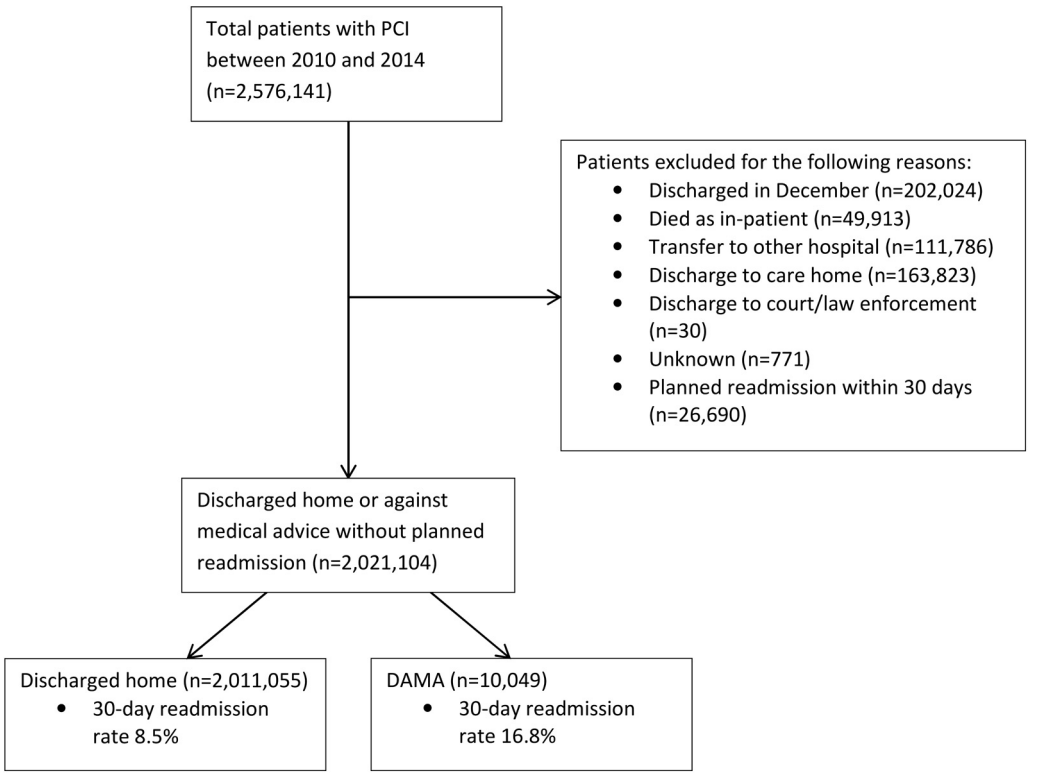

Figure showing the flow diagram of patients included in the analysis and the proportion of patients who discharge against medical advice (DAMA) and patients who are discharged home as well as their respective 30-day readmission rates. PCI = percutaneous coronary intervention.

FIGURE 2 Percentage of Patients Who Undergo PCI and DAMA

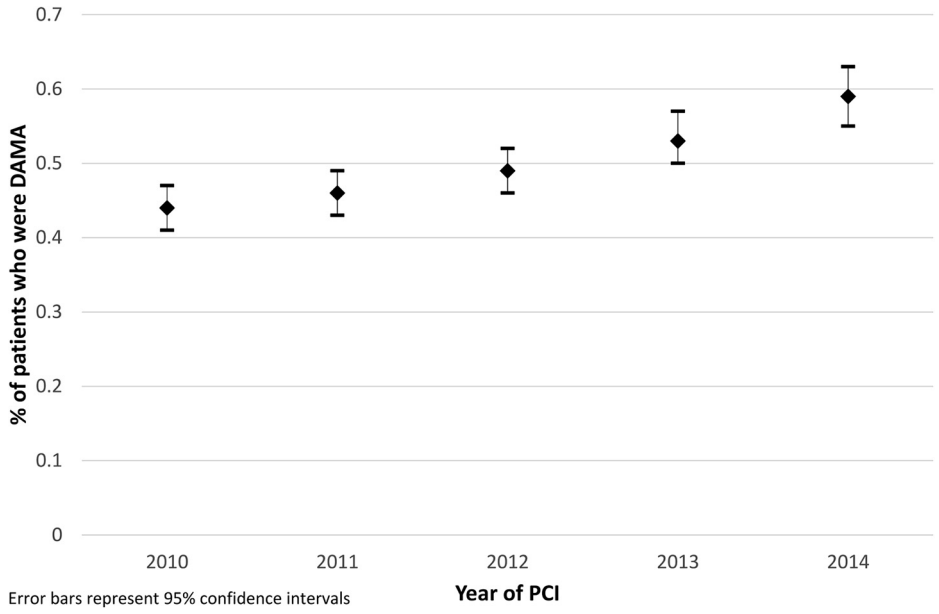

Figure showing the increase in patients who were discharged against medical advice (DAMA) over time. Abbreviations as in Figure 1.

TABLE 1 Patient Characteristics at Index Hospital Admission According to DAMA Status

	Not DAMA (n = 2,011,055)	DAMA (n = 10,049)	p Value
Age, yrs	63.7 ± 12.0	57.2 ± 11.9	<0.001
Women	30.6	18.9	<0.001
Elective	17.3	8.2	<0.001
Weekend	20.0	23.4	<0.001
Diagnosis of acute myocardial infarction	50.7	65.7	<0.001
Primary expected payer			<0.001
Medicare	49.3	40.9	
Medicaid	7.7	19.8	
Private	32.3	16.1	
Uninsured	6.1	16.5	
No charge	0.8	1.7	
Other	3.8	5.1	
Median household income, percentile			<0.001
0–25th	28.8	35.6	
26–50th	25.3	26.8	
51–75th	24.0	22.7	
76–100th	22.0	15.0	
Smoker	42.7	65.6	<0.001
Alcohol misuse	2.6	8.4	<0.001
Dyslipidemia	72.8	59.9	<0.001
Hypertension	74.4	70.7	<0.001
Diabetes mellitus	35.7	35.0	0.34
Obesity	15.9	15.4	0.35
Heart failure	0.7	1.6	<0.001
Known coronary artery disease	94.6	91.8	<0.001
Previous myocardial infarction	14.3	19.6	<0.001

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In the current study, we included men and women 18 years of age or older who underwent first PCI between 2010 and 2014, and were either DAMA or discharged home. First PCI was defined by first procedure of PCI within a calendar year. DAMA was defined from the variable "DISPUNIFORM," which represents the disposition of patient at discharge. We excluded patients who died during their index admission for PCI, those who had an elective readmission, and those who were not discharged home or against medical advice.

VARIABLES AND OUTCOMES. The data collected are described in the Online Appendix. We used International Classification of Disease-Ninth Revision-Clinical Modification and Clinical Classification Software of diseases codes to determine comorbidities, in-hospital procedures, and outcomes. The cost of clinical care was determined by the claims change multiplied by the cost-to-charge ratio. Thirty-day readmissions were defined as first rehospitalization after discharge within 30 days from admission for PCI. The causes of readmissions were determined from the principle diagnosis based on Clinical Classification Software codes as outlined in Online Table 1. The primary endpoint was all-cause 30-day readmissions and reasons for readmissions.

STATISTICAL ANALYSIS. Statistical analysis was performed using Stata 14.0 (StataCorp, College Station,

Texas). A flow diagram was used to determine the proportion of patients at each stage of the analysis and those who were readmitted as well as those who died on readmission. Descriptive statistics were used to compare patients who were DAMA compared with those who were discharged home, with further stratification depending on whether or not they were readmitted. Statistical differences between groups for continuous variables were tested using the *t* test and for categorical variables the chi-square test. For all analyses, the survey estimation commands were used (e.g., svy: logistic for multiple logistic regression), following the recommendations from Agency for Healthcare Research and Quality for analysis of survey data to account for the complex survey design of the NRD database. Multiple logistic regressions were used to determine independent variables associated with DAMA and 30-day readmission. We performed sensitivity analysis in the subgroup of patients in which elective cases were excluded. The major cardiac and noncardiac causes of readmission for the DAMA and discharged home groups are presented in the tables.

RESULTS

A total of 2,021,104 participants were included in the analysis after exclusion of patients who died after first PCI (n = 49,913), had an elective readmission (n = 26,690), or were discharged to other places of care (n = 276,410) (**Figure 1**). The overall proportion of patients who DAMA over the whole study period was 0.5% (n = 10,049). **Figure 2** illustrates the temporal trends for DAMA at the index PCI procedure, increasing from 0.44 in 2010 to 0.59 in 2014 ($p < 0.001$ for trend). The 30-day readmission rate for patients who DAMA and those who were non-DAMA was 16.8% and 8.5%, respectively.

The participant characteristics and in-hospital outcomes for the index PCI admission for patients stratified by whether they DAMA are shown in **Table 1**. Patients who DAMA were younger (57.2 vs. 63.7 years), less likely to be women (18.9% vs. 30.6%), less likely to be admitted electively (8.2% vs. 17.3%), and in the lowest quartile of income (36.5% vs. 27.8%). Those who DAMA were more likely to be admitted on a weekend (35.6% vs. 28.8%) and receive Medicaid (19.8% vs. 7.7%). Significant differences were observed for most comorbidities, as well as smoking (65.6% vs. 42.7%; $p < 0.001$), alcohol misuse (8.4% vs. 2.6%) and drug abuse (10.7% vs. 2.1%; $p < 0.001$). A longer length of stay (3.2 vs. 3.0 days) and cost of index PCI ($20,441 vs. $19,732) was observed in patients who DAMA.

TABLE 1 Continued

	Not DAMA (n = 2,011,055)	DAMA (n = 10,049)	p Value
Previous percutaneous coronary intervention	21.3	25.4	<0.001
Previous coronary artery bypass graft	7.8	7.5	0.43
Previous valve disease	0.2	0.4	0.17
Atrial fibrillation	9.8	7.9	<0.001
Previous transient ischemic attack/stroke	6.1	6.9	0.018
Peripheral vascular disease	10.2	10.7	0.29
Pulmonary circulatory disorder	0.1	0.3	0.04
Peptic ulcer disease	0.02	0.00	0.33
Chronic lung disease	15.4	22.0	<0.001
Renal failure	11.4	12.3	0.064
Liver disease	1.2	2.0	<0.001
Hypothyroidism	8.5	4.3	<0.001
Fluid and electrolyte disorders	9.9	13.8	<0.001
Anemia	8.5	9.7	0.007
Cancer	1.6	1.5	0.5
Depression	6.10	7.00	0.025
Dementia	1.1	0.9	0.41
Charlson Comorbidity Index	1.2 ± 1.3	1.3 ± 1.4	<0.001
Mean number of comorbidities	4.7 ± 2.0	5.0 ± 2.1	<0.001
Bed size			0.02
Small	5.8	4.8	
Medium	20.7	21.0	
Large	73.5	74.2	
Location			0.43
Rural	0.2	0.3	
Urban	99.8	99.8	
Teaching status			<0.001
Nonteaching	45.4	49.8	
Teaching status	54.7	50.2	
In-hospital procedures and procedural details			
Multivessel disease	16.1	12.6	<0.001
Bifurcation	2.9	2.2	0.013
Circulatory support	2.1	3.4	<0.001
Vasopressor use	0.3	0.3	0.74
Intra-aortic balloon pump	1.8	3.2	<0.001
Fractional flow reserve	1.9	1.1	<0.001
Intravascular ultrasound	7.1	5.3	<0.001
Drug-eluting stent	75.8	59.2	<0.001
In-hospital outcomes			
Complete heart block	0.8	0.9	0.37
Transient ischemic attack/stroke	2.5	2.5	0.97
Cardiogenic shock	1.7	3.4	<0.001
Cardiac arrest	1.2	2.1	<0.001
Acute kidney injury	0.4	1.1	<0.001
Major bleeding	0.4	1.1	<0.001
Blood transfusion	0.4	1.1	0.33
Vascular complication	0.6	0.5	0.26
Emergency coronary artery bypass graft	0.7	0.5	0.16
Length of stay, days	3.0 ± 3.2	3.2 ± 7.7	<0.001
Cost for first admission, $	19,732 ± 12,168	20,441 ± 17,759	<0.001
Readmission			
30-day readmission	8.5	16.8	<0.001
Cost of readmission, $	11,380 ± 15,857	13,717 ± 18,774	<0.001

Values are mean ± SD or %.
DAMA = discharged against medical advice.

TABLE 2 Patient Characteristics According to DAMA Status

	Not Readmitted			Readmitted		
	Not DAMA (n = 1,840,178)	DAMA (n = 8,364)	p Value	Not DAMA (n = 170,877)	DAMA (n=1,685)	p Value
Age, yrs	63.5 ± 12.0	57.1 ± 11.7	<0.001	65.2 ± 12.6	58.0 ± 12.6	<0.001
Women	30.0	18.6	<0.001	37.3	20.7	<0.001
Elective	17.8	8.7	<0.001	12.2	6.0	<0.001
Weekend	19.9	23.5	<0.001	21.0	23.1	0.18
Diagnosis of acute myocardial infarction	50.9	66.1	<0.001	48.9	63.6	<0.001
Primary expected payer			<0.001			<0.001
Medicare	48.4	39.6		58.2	46.8	
Medicaid	7.5	19.2		10.0	22.7	
Private	33.2	16.7		22.6	13.0	
Uninsured	6.2	17.6		4.9	11.1	
No charge	0.9	1.8		0.8	1.4	
Other	3.9	5.1		3.5	5.0	
Median household income, percentile			<0.001			<0.001
0–25th	28.6	35.1		30.9	38.1	
26–50th	25.2	27.3		25.4	24.2	
51–75th	24.0	23.0		23.4	21.2	
76–100th	22.1	14.6		20.2	16.6	
Smoker	42.8	66.0	<0.001	41.4	63.7	<0.001
Alcohol misuse	2.6	7.9	<0.001	2.8	10.7	<0.001
Dyslipidemia	73.0	59.8	<0.001	70.4	60.1	<0.001
Hypertension	74.1	69.7	<0.001	77.9	75.9	0.22
Diabetes mellitus	35.0	33.6	0.085	43.0	41.7	0.51
Obesity	15.9	15.3	0.36	16.2	15.7	0.75
Heart failure	0.7	1.5	<0.001	1.3	2.1	0.082
Known coronary artery disease	94.6	92.1	<0.001	94.9	90.5	<0.001
Previous myocardial infarction	14.2	19.5	<0.001	15.8	20.2	0.001
Previous percutaneous coronary intervention	21.2	25.6	<0.001	22.3	24.2	0.22
Previous coronary artery bypass graft	7.7	7.2	0.33	9.4	8.8	0.59
Previous valve disease	0.2	0.3	0.5	0.4	0.7	0.3
Atrial fibrillation	9.3	7.0	<0.001	14.8	12.4	0.72
Previous transient ischemic attack/stroke	5.8	6.1	0.46	8.7	11.0	0.028
Peripheral vascular disease	9.8	10.1	0.53	14.1	13.4	0.58
Pulmonary circulatory disorder	0.1	0.2	0.11	0.3	0.4	0.41
Peptic ulcer disease	0.02	0.00	0.37	0.02	0.00	0.67
Chronic lung disease	14.8	20.9	<0.001	22.2	28.0	<0.001
Renal failure	10.6	10.7	0.92	19.6	20.3	0.66
Liver disease	1.1	1.8	<0.001	1.8	3.1	0.014
Hypothyroidism	8.3	4.1	<0.001	10.5	5.4	<0.001
Fluid and electrolyte disorders	9.4	12.2	<0.001	14.8	21.8	<0.001
Anemia	7.9	8.3	0.37	15.2	16.4	0.39
Cancer	1.5	1.4	0.56	2.5	1.8	0.27
Depression	5.9	6.6	0.09	8.4	8.8	0.75
Dementia	1.0	0.8	0.15	1.8	1.8	0.94
Charlson Comorbidity Index	1.1 ± 1.3	1.3 ± 1.4	<0.001	1.6 ± 1.6	1.8 ± 1.6	0.004
Mean number of comorbidities	4.7 ± 2.0	4.9 ± 2.1	<0.001	5.3 ± 2.2	5.6 ± 2.2	<0.001
Bed size			0.037			0.29
Small	5.9	4.9		5.1	4.3	
Medium	20.7	21.4		20.5	18.8	
Large	73.4	73.6		74.4	76.9	
Location			0.52			0.54
Rural	0.2	0.3		0.2	0.3	
Urban	99.8	99.7		99.8	99.7	
Teaching status			<0.001			0.032
Nonteaching	45.3	49.7		46.1	50.1	
Teaching status	54.7	50.3		53.9	49.9	

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TABLE 2 Continued

	Not Readmitted			Readmitted		
	Not DAMA (n = 1,840,178)	DAMA (n = 8,364)	p Value	Not DAMA (n = 170,877)	DAMA (n=1,685)	p Value
In-hospital procedures and procedural details						
Multivessel disease	16.1	12.6	<0.001	16.2	12.5	0.008
Bifurcation	2.9	2.3	0.028	2.7	2.1	0.31
Circulatory support	2.0	2.9	<0.001	3.0	5.6	<0.001
Vasopressor use	0.3	0.2	0.25	0.4	0.7	0.19
Intra-aortic balloon pump	1.7	2.8	<0.001	2.7	5.0	<0.001
Fractional flow reserve	1.9	1.1	<0.001	2.1	1.5	0.31
Intravascular ultrasound	7.1	5.3	<0.001	7.2	4.9	0.017
Drug-eluting stent	76.3	60.2	<0.001	70.9	54.4	<0.001
In-hospital outcomes						
Complete heart block	0.8	1.0	0.16	0.9	0.6	0.32
Transient ischemic attack/stroke	2.4	2.2	0.39	3.0	3.8	0.27
Cardiogenic shock	1.6	2.8	<0.001	2.5	6.4	<0.001
Cardiac arrest	1.2	2.0	<0.001	1.4	2.6	0.004
Acute kidney injury	0.3	1.0	<0.001	0.7	1.8	<0.001
Major bleeding	0.4	1.0	<0.001	0.7	1.8	<0.001
Blood transfusion	0.02	0.00	0.39	0.03	0.00	0.63
Vascular complication	0.6	0.4	0.13	0.8	0.8	0.87
Emergency coronary artery bypass graft	0.7	0.5	0.091	0.7	0.8	0.86
Length of stay, days	2.9 ± 3.2	3.1 ± 8.3	0.009	3.6 ± 3.0	3.7 ± 3.9	0.51
Cost for first admission, $	19,606 ± 12,182	20,030 ± 18,138	0.04	21,090 ± 11,938	22,469 ± 15,606	0.002
Readmission						
30-day readmission	-	-	-	100.0	100.0	-
Cost of readmission, $	-	-	-	11,380 ± 15,857	13,718 ± 18,774	0.001

Values are mean ± SD or %.
DAMA = discharged against medical advice.

Table 2 shows the patient variables according to 30-day readmission status stratified by DAMA status. Among patients who were not readmitted, patients who DAMA were more likely to be smokers (66.0% vs. 42.8%), abuse alcohol (7.9% vs. 2.6%), abuse drugs (10.3% vs. 2.0%), have a previous myocardial infarction (MI) (19.5% vs. 14.2%), have a previous PCI (25.6% vs 21.2%), and have chronic lung disease (20.9% vs. 14.8%), and were less likely to receive a drug-eluting stent (60.2% vs. 76.3%). For patients who were readmitted, those who DAMA were more likely to be smokers (63.7% vs. 41.4%), misuse alcohol (10.7% vs. 2.8%), abuse drugs (10.7% vs. 2.8%), have chronic lung disease (28.0% vs. 22.2%), and have fluid and electrolyte disorders (21.8% vs. 14.8%), and less likely to receive a drug-eluting stent (54.4% vs. 70.9%). A greater proportion of DAMA patients were uninsured and from the lowest median household income irrespective of readmission status. **Table 3** shows the readmissions outcomes for patients according to whether or not the patient DAMA. DAMA was associated with greater death (3.2% vs. 2.0%), in-hospital major adverse cardiac events (6.1% vs. 2.4%), and DAMA in the readmission (13.9% vs. 1.1%). Similar increases were observed for both in the whole cohort of patients undergoing PCI and the subgroup of patients who were admitted with a diagnosis of acute MI.

TABLE 3 Readmission Outcomes for All PCI Patients and for Those With Acute MI at Index Admission

	Not DAMA at Index PCI	DAMA at Index PCI	p Value
All readmissions			
Death in readmission	2.0	3.2	0.017
In-hospital MACE for readmission	2.4	6.1	<0.001
Cost of readmission, $	11,380 ± 15,857	13,718 ± 18,774	<0.001
Discharge against medical advice for readmission	1.1	13.9	<0.001
Acute myocardial infarction			
Death in readmission	2.4	5.0	<0.001
In-hospital MACE for readmission	2.5	7.3	<0.001
Cost of readmission, $	11,936 ± 15,941	15,183 ± 20,851	<0.001
Discharge against medical advice for readmission	1.1	12.2	<0.001

Values are % or mean ± SD. Major adverse cardiac events (MACE) is defined as a primary diagnosis of acute myocardial infarction (MI), stroke, or transient ischemic attack, re-PCI, emergency coronary artery bypass grafting, and in-hospital death.
DAMA = discharged against medical advice; PCI = percutaneous coronary intervention.

TABLE 4 Multiple Logistic Regression to Identify Independent Variables Associated With Patients Who DAMA

	Odds Ratio (95% CI)	p Value
Age, per 1-yr increment	0.96 (0.95-0.96)	<0.001
Female	0.58 (0.53-0.64)	<0.001
Elective	0.66 (0.57-0.76)	<0.001
Diagnosis of acute myocardial infarction	1.37 (1.25-1.51)	<0.001
Primary expected payer vs. Medicare		
Medicaid	1.23 (1.09-1.39)	0.001
Private	0.32 (0.28-0.36)	<0.001
Other	0.73 (0.61-0.87)	0.001
Median household income, 76-100th percentile vs. 0-25th percentile	0.88 (0.79-0.87)	0.041
Smoker	1.71 (1.57-1.86)	<0.001
Alcohol misuse	1.53 (1.32-1.78)	<0.001
Drug abuse	1.82 (1.60-2.06)	<0.001
Dyslipidemia	0.63 (0.58-0.68)	<0.001
Diabetes mellitus	1.12 (1.03-1.21)	0.008
Obesity	0.89 (0.80-0.98)	0.019
Heart failure	1.66 (1.17-2.37)	0.005
Known coronary artery disease	0.83 (0.73-0.95)	0.006
Previous myocardial infarction	1.33 (1.20-1.48)	<0.001
Previous percutaneous coronary intervention	1.34 (1.22-1.48)	<0.001
Previous coronary artery bypass graft	1.16 (1.01-1.37)	0.041
Peripheral vascular disease	1.19 (1.05-1.35)	0.006
Chronic lung disease	1.31 (1.20-1.43)	<0.001
Renal failure	1.18 (1.05-1.33)	0.005
Hypothyroidism	0.73 (0.61-0.87)	<0.001
Fluid and electrolyte disorders	1.12 (1.03-1.25)	0.041
Dementia	1.52 (1.03-2.24)	0.036
Teaching status	0.81 (0.74-0.89)	<0.001
Intravascular ultrasound	0.79 (0.66-0.94)	0.008
Drug-eluting stent	0.64 (0.59-0.70)	<0.001
Acute kidney injury	2.45 (1.73-3.48)	<0.001
Emergency coronary artery bypass graft	0.42 (0.27-0.68)	<0.001

CI = confidence interval; DAMA = discharge against medical advice.

The predictors of DAMA are shown in **Table 4**. Predictors of DAMA included smoking (odds ratio [OR]: 1.71; 95% confidence interval [CI]: 1.57 to 1.86), alcohol misuse (OR: 1.53; 95% CI: 1.32 to 1.78), and dementia (OR: 1.52; 95% CI: 1.03 to 2.24), whereas female sex (OR: 0.58; 95% CI: 0.53 to 0.63) and elective admissions (OR: 0.66; 95% CI: 0.57 to 0.76) were independently associated with reduced odds of DAMA. Among patients with acute MI, the strongest predictor of DAMA was acute kidney injury (OR: 2.51; 95% CI: 1.53 to 4.13), although drug (OR: 1.83; 95% CI: 1.57 to 2.13) and alcohol (OR: 1.28; 95% CI: 1.07 to 1.53) abuse and smoking (OR: 1.77; 95% CI: 1.59 to 1.97) remained independent predictors of DAMA (Online Table 2).

Table 5 shows the independent predictors of 30-day readmission. DAMA was the strongest predictor of 30-day unplanned readmissions (OR: 1.89; 95% CI: 1.71 to 2.08) for all patients and for patients with admission for acute MI (OR: 1.96; 95% CI: 1.73 to 2.22) (Online Table 2).

The causes of unplanned 30-day readmissions were subsequently studied in patients who DAMA and those who were discharged home. **Table 6** shows that the proportion of patients with noncardiac readmissions was higher in patients who were discharged home (54.5% vs. 45.5%) whereas the rates of cardiac and noncardiac readmission were similar for the DAMA group (50.2% vs. 49.8%).

Table 6 shows the most common noncardiac and cardiac causes for readmission according to whether patients were DAMA or non-DAMA. Nonspecific chest pain was the commonest noncardiac cause for readmission for both patients who DAMA and those who discharge home (19.7% and 20.2%, respectively). For noncardiac readmissions, patients who DAMA were more likely to have neuropsychiatric causes for readmission (8.3%, fourth-most-common cause of readmission) compared with those patients discharged home (2.4%, 10th-most-common cause). The specific causes of psychiatric readmissions in the DAMA group were mainly due to depression, bipolar and mood disorders (43.3%), and paranoid schizophrenia, schizoaffective disorder, and psychosis (16.7%) (Online Table 3). In terms of cardiac readmissions, acute MI was the most common diagnosis code for both cohorts, although patients who DAMA were twice as likely to be readmitted with the diagnosis code of acute MI (39.4% vs. 19.5%) compared with those discharged home. For patients presenting with acute MI at their index admission, DAMA was associated with increase rates of cardiac readmissions (56.6% vs. 49.2%) (Online Table 2). Noncardiac chest pain was the most common reason for noncardiac readmissions. The most frequent reasons for cardiac readmission for both DAMA and not DAMA in the acute MI groups were diagnosis of acute MI and coronary artery disease, including angina.

DISCUSSION

DAMA is a rare occurrence among patients who undergo PCI, and is strongly related to smoking and alcohol misuse and is less likely to occur among patients who are women, are privately insured, have a higher quartile of income, or are admitted for elective PCI. Whereas the rates of DAMA appear to be rising, it is still a relatively rare occurrence.

We show that patients who DAMA are a high-risk cohort. They have a 2-fold increased risk of readmission and are twice as likely to be readmitted with the diagnosis code of acute MI and 4 times as likely to be readmitted with an acute neuropsychiatric episode. To the best of our knowledge, we show, for the first time, that DAMA is one of the strongest predictors of unplanned 30-day readmission after PCI. Our results provide evidence that patients who DAMA should be considered to be at high risk. Our findings support the need for a greater understanding of patients who DAMA to further develop interventions to either reduce it or the development of pathways that allow follow-up of patients that DAMA.

Our study provides novel insight into patients who DAMA after PCI, and temporal trends, predictors, and outcomes associated with DAMA in PCI have not been explored before. It is unclear whether the observed changes are a result of changes in the demographics of the patients that present for PCI or because of changes in the care delivered that may influence patient decisions. We show evidence that is consistent with published reports outside the PCI setting that being young and male are factors associated with DAMA. We also find that smokers and patients who misuse alcohol are at higher risk, and decisions to DAMA in these patients may be motivated by substance-seeking behavior.

Our findings suggest that patients undergoing elective procedures are less likely to DAMA, which suggests that there may be an element of selection bias for such procedures, with patients in which there may be issues around compliance or future engagement with health care less likely to be offered an elective PCI. By contrast, in PCI procedures undertaken in the short-term setting of an acute MI, selection based on future compliance or engagement with health care services is not feasible, which may explain the increased risk of DAMA associated with the readmission diagnosis code of MI.

We show, for the first time, the reasons for readmissions after DAMA in patients who undergo PCI. A key finding here is that patients who DAMA have a 4-fold increased rate of neuropsychiatric unplanned 30-day readmissions compared with patients discharged home. Our detailed analysis of specific causes of readmission suggests that depression, bipolar disorder, and mood disorders are the most common reasons for readmission, with previous published reports reporting that coronary artery intervention can increase patients' anxiety

TABLE 5 Multiple Logistic Regression to Determine Independent Variables Associated With Readmission Within 30 Days

	Odds Ratio (95% CI)	p Value
All patients		
DAMA	1.89 (1.71–2.08)	<0.001
Age, per 1-year increment	1.00 (1.00–1.00)	0.011
Female	1.23 (1.21–1.26)	0.001
Elective	0.62 (0.59–0.64)	<0.001
Diagnosis of acute myocardial infarction	0.89 (0.87–0.91)	<0.001
Primary expected payer vs. Medicare		
Medicaid	1.12 (1.08–1.17)	<0.001
Private	0.70 (0.68–0.72)	<0.001
Uninsured	0.74 (0.71–0.78)	<0.001
No charge	0.89 (0.80–0.99)	0.031
Other	0.82 (0.78–0.87)	<0.001
Median household income vs. 0–25th percentile		
26–50th	0.97 (0.93–0.97)	<0.001
76–100th	0.96 (0.92–0.99)	0.012
Smoker	0.95 (0.93–0.97)	<0.001
Drug abuse	1.35 (1.28–1.43)	<0.001
Dyslipidemia	0.88 (0.86–0.90)	<0.001
Hypertension	1.07 (1.04–1.09)	<0.001
Diabetes mellitus	1.21 (1.18–1.23)	<0.001
Obesity	0.94 (0.91–0.96)	<0.001
Previous coronary artery bypass graft	1.09 (1.05–1.13)	<0.001
Atrial fibrillation	1.41 (1.37–1.45)	<0.001
Previous transient ischemic attack/stroke	1.19 (1.14–1.22)	<0.001
Peripheral vascular disease	1.18 (1.14–1.23)	<0.001
Chronic lung disease	1.38 (1.34–1.42)	<0.001
Renal failure	1.48 (1.44–1.53)	<0.001
Liver disease	1.37 (1.27–1.47)	<0.001
Hypothyroidism	1.04 (1.00–1.07)	0.035
Fluid and electrolyte disorders	1.21 (1.18–1.25)	<0.001
Anemia	1.36 (1.32–1.40)	<0.001
Cancer	1.39 (1.30–1.49)	<0.001
Depression	1.24 (1.20–1.29)	<0.001
Dementia	1.25 (1.16–1.35)	<0.001
Teaching hospital	0.97 (0.94–0.99)	0.017
Intra-aortic balloon pump	1.21 (1.01–1.46)	0.041
Fractional flow reserve	1.09 (1.02–1.17)	0.011
Drug-eluting stent	0.84 (0.83–0.86)	<0.001
Cardiogenic shock	1.12 (1.04–1.20)	0.002
Vascular complication	1.13 (1.01–1.25)	0.032
Emergency coronary artery bypass graft	0.86 (0.76–0.96)	0.010
Elective only		
DAMA	1.91 (1.17–3.11)	0.010
Female	1.27 (1.19–1.35)	<0.001
Primary expected payer vs. Medicare		
Private	0.73 (0.66–0.80)	<0.001
Dyslipidemia	0.89 (0.82–0.96)	0.003
Diabetes mellitus	1.13 (1.05–1.22)	0.001
Previous percutaneous coronary intervention	0.86 (0.80–0.93)	<0.001
Atrial fibrillation	1.38 (1.24–1.53)	<0.001
Previous transient ischemic attack/stroke	1.25 (1.09–1.43)	0.002
Peripheral vascular disease	1.18 (1.07–1.30)	0.001
Chronic lung disease	1.35 (1.23–1.48)	<0.001
Renal failure	1.46 (1.34–1.60)	<0.001
Liver disease	1.49 (1.11–2.00)	0.008

Continued on the next page

TABLE 5 Continued

	Odds Ratio (95% CI)	p Value
Fluid and electrolyte disorders	1.31 (1.14–1.52)	<0.001
Anemia	1.42 (1.24–1.62)	<0.001
Cancer	1.33 (1.03–1.72)	0.031
Depression	1.38 (1.20–1.60)	<0.001
Fractional flow reserve	1.31 (1.08–1.60)	0.007
Drug-eluting stent	0.83 (0.77–0.91)	<0.001
Vascular complication	1.42 (1.06–1.88)	0.020
Emergency coronary artery bypass graft	1.41 (1.06–1.88)	0.018
Acute myocardial infarction		
DAMA	1.96 (1.73–2.22)	<0.001
Female	1.29 (1.25–1.33)	<0.001
Primary expected payer vs Medicare		
Medicaid	1.19 (1.12–1.26)	<0.001
Private	0.70 (0.67–0.73)	<0.001
Uninsured	0.75 (0.71–0.80)	<0.001
Other	0.82 (0.76–0.88)	<0.001
Smoker	0.91 (0.89–0.94)	<0.001
Drug abuse	1.30 (1.20–1.40)	<0.001
Dyslipidemia	0.90 (0.87–0.93)	<0.001
Hypertension	1.09 (1.05–1.13)	<0.001
Diabetes mellitus	1.21 (1.18–1.23)	<0.001
Obesity	0.90 (0.87–0.94)	<0.001
Previous heart failure	0.76 (0.59–0.98)	0.033
Atrial fibrillation	1.40 (1.39–1.52)	<0.001
Previous transient ischemic attack/stroke	1.19 (1.13–1.26)	<0.001
Peripheral vascular disease	1.21 (1.15–1.27)	<0.001
Chronic lung disease	1.38 (1.32–1.43)	<0.001
Renal failure	1.52 (1.46–1.59)	<0.001
Liver disease	1.30 (1.16–1.45)	<0.001
Fluid and electrolyte disorders	1.21 (1.16–1.26)	<0.001
Anemia	1.36 (1.30–1.43)	<0.001
Cancer	1.54 (1.40–1.70)	<0.001
Depression	1.18 (1.11–1.25)	<0.001
Dementia	1.32 (1.18–1.47)	<0.001
Teaching hospital	0.96 (0.93–0.99)	0.023
Intra-aortic balloon pump	1.38 (1.03–1.84)	0.031
Fractional flow reserve	1.14 (1.00–1.30)	0.046
Drug-eluting stent	0.82 (0.79–0.84)	<0.001
Cardiogenic shock	1.10 (1.01–1.20)	0.029
Emergency coronary artery bypass graft	0.85 (0.73–1.00)	0.047

Abbreviations as in Table 4.

TABLE 6 Cause of Readmission by DAMA Status

	Not DAMA (%)	DAMA (%)
Cause of readmission		
Cardiac	45.5	49.8
Noncardiac	54.5	50.2
Cause of noncardiac readmission		
Nonspecific chest pain	20.2	19.7
Infections	9.3	10.2
Respiratory	7.5	9.7
Neuropsychiatric	2.4	8.3
Gastrointestinal	11.4	6.9
Peripheral vascular disease	4.4	5.0
Renal failure	3.2	3.9
Bleeding	5.3	3.6
TIA/stroke	4.4	3.0
Hematologic/neoplasm	2.7	2.2
Cause of cardiac readmission		
Diagnosis of acute myocardial infarction	19.5	39.4
Coronary artery disease including angina	42.4	29.3
Heart failure	19.1	17.6
Arrhythmias	14.0	11.5
Pericarditis	1.4	0.8
Valve disorders	0.7	0.6
Conduction disorders	0.7	0.0
Hyper/hypotension	0.0	0.0
Other cardiac readmission	2.1	0.8

DAMA = discharge against medical advice; TIA = transient ischemic attack.

and depression (10). In the current study, both smoking (11) and alcohol misuse (12) were independently associated with DAMA, and these 2 factors have also been linked to mental illness. We also report that patients who DAMA are twice as likely to be readmitted with the diagnosis code of acute MI. This is an important finding and may relate to failure to prescribe dual antiplatelet therapy (DAPT) to patients who DAMA, or failure for their continuing prescription once discharged which significantly increases the risk of stent thrombosis. It is unclear from this study whether patients who DAMA were prescribed medications such as antiplatelet agents before DAMA or whether these patients had any follow-up with medical services once discharged for continued receipt of pharmacotherapy. Interestingly, one study of general admissions suggests that only 21.4% of patients had medications prescribed when patients DAMA (13).

DAMA in the context of PCI are unlike DAMA in the emergency department and general hospital admissions that have been reported in the published reports (14–16). A patient who is seen at the emergency department may not receive treatment, and similarly, a patient admitted to hospital may be admitted for investigations and observation initially. By contrast, patients who undergo PCI have received a treatment that requires ongoing management and medical therapy to ensure optimal future outcomes. In patients who DAMA at some point after the procedure, there is a breakdown in the care relationship, and the patient chooses to discontinue care. This can have serious consequences because ongoing patient care is required after PCI, with prescription

of DAPT to reduce the risk of stent thrombosis or an echocardiogram to assess for left ventricular function after an acute event enabling prescription of evidence-based therapies that reduce the risk of rehospitalization (17), or management of newly diagnosed diabetes mellitus and so forth. Furthermore, whereas a patient who DAMA in the emergency department and general hospital inpatient stay may carry the risks associated with the presenting condition, the patients who undergo PCI may carry the risks associated with their presenting condition but also those related to their treatment (PCI).

THE NEED FOR INTERVENTIONS FOR DAMA PATIENTS. Our findings suggest that an evidence base around understanding reasons for DAMA in the context of PCI should be developed, with interventions developed to reduce DAMA or at least obviate the risks in situations where it does occur. A previous qualitative study proposed several strategies to reduce DAMA in cardiovascular disease (9). First, patients highlighted that communications needed to be improved, and health care providers should receive training in cultural diversity, interpersonal skills, and customer service and also be more truthful and accurate regarding wait times. Nurses further suggested that the quality of verbal communication needed to be improved to manage patient's expectations to minimize false promises. The principles of these findings could potentially be applied to settings where PCI has been undertaken to potentially reduce rates of DAMA. Secondly, in cases in which DAMA has occurred, interventions need to be developed to obviate potential risks, particularly around the prescription of DAPT and other cardiac medications in this patient group. This may require the development of targeted interventions across health care providers spanning the secondary and primary care interface, or the development of pharmacy outreach programs that enable prescription or continuation of therapies in the community. Finally, given that neuropsychiatric causes are an important cause of unplanned 30-day readmissions in patients who DAMA, involvement of psychiatric services, particularly in those with a history of mental health conditions or a history of substance abuse, early on in the index admission for patients undergoing PCI particularly in the short-term setting, may decrease the risk of DAMA or at least provide an arena for safer "discharge" planning, even in those who do subsequently DAMA. Another area of future work should explore the care that patients are deprived of by choosing to DAMA. There is likely a portion of patients who require further treatment, and these patients may be at higher risk of adverse events, but also patients who have received PCI treatment and are recommended to stay in hospital for a period of observation.

STUDY STRENGTHS AND LIMITATIONS. Our study has several strengths. First, this is the first study to evaluate DAMA in the context of PCI in a large cohort that has sufficient sample size to capture these uncommon events. Second, the data from the NRD are largely complete, which minimizes biases related to missing data. Finally, we were able to adjust for a variety of confounders in our models to predict DAMA and 30-day readmission, including many socioeconomic factors, comorbidities, hospital characteristics, procedural variables, and outcomes.

There are several limitations in the current study. First, the overall data are derived from 5 unique datasets corresponding to each year in the period between 2010 to 2014, and no linkage is possible between years. Second, the dataset does not capture pharmacotherapy data such as DAPT, and thus prescription fill rates and compliance are unknown in patients who DAMA. Third, although we report a 2-fold increased odds of readmission with diagnosis code of acute MI in patients who DAMA, there are no diagnostic codes for stent thrombosis, and so we were unable to determine whether this increased risk relates to stent thrombosis events, or reflects a worse cardiovascular risk factor profile in patients who self-discharge for de novo events. Fourth, the study is a retrospective analysis of an administrative database that was collected from administrative claims sampled from 21 states but may not be generalizable to all settings, because regional heterogeneity was not explored. In addition, we were unable to capture out-of-hospital deaths, so our results may underestimate the extent of poor outcomes associated with patients who DAMA. Also, we were not able to exclude the possibility that the same patient may appear in multiple years because the database is composed of 5 annual datasets, which cannot be linked across years. Furthermore, as with any such administrative database, coding errors are always a potential source of bias, as is underreporting of secondary and comorbid diagnoses. Finally, causes of readmission were identified using the primary discharge diagnosis codes, which may be subject to reporting biases.

CONCLUSIONS

DAMA occurs in 0.5% of patients who undergo PCI and is strongly associated with a greater risk of 30-day unplanned readmission with higher mortality. We identified that patients who have previous MI, are smokers, and misuse alcohol and drugs are most likely to DAMA. This information may be useful for clinicians to identify those patients upon admission or shortly after that are at high risk of DAMA, allowing clinicians to better tailor care so that the management is supported and agreed on by these patients, and there is no breakdown in the therapeutic relationship.

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PERSPECTIVES

WHAT IS KNOWN? DAMA is associated with poor patient outcomes and DAMA in the context of PCI has not been described in the published reports.

WHAT IS NEW? Our analysis of 2,021,104 patients reveals that the proportion of patients who DAMA was 0.5%, and important predictors of DAMA included diagnosis of acute MI, smoking, and alcohol misuse. DAMA was the strongest predictor for unplanned 30-day readmission (OR: 1.89; 95% CI: 1.71 to 2.08; $p < 0.001$) and DAMA patients were more likely to have neuropsychiatric reasons for noncardiac causes of readmission and acute MI for cardiac causes of readmission compared with patients discharged home. DAMA following PCI is rare, but it is strongly associated with readmissions within 30 days.

WHAT IS NEXT? Interventions should be developed to reduce DAMA in high-risk groups and initiate interventions to avoid complications and readmission when it occurs.

REFERENCES

1. Alfandre DJ. "I'm going home": discharge against medical advice. Mayo Clin Proc 2009;84:255-60.

2. Tawk R, Freels S, Mullner R. Association of mental, and medical illness with against medical advice discharges: the National Hospital Discharge Survey, 1988-2006. Adm Policy Ment Health 2013;40:124–32.

3. Glasgow JM, Vaughn-Sarrazin M, Kaboli PJ. Leaving against medical advice (AMA): risk of 30-day mortality and hospital readmission. J Gen Intern Med 2010;25:926–9.

4. Greenwald AF, Bartemeier LH. Psychiatric discharges against medical advice. Arch Gen Psychiatry 1963;8:117–9.

5. Levine J, Monroe JJ. Discharge of narcotic drug addicts against medical advice. Public Health Rep 1964;79:13–8.

6. Greenwald AF, Bartemeier LH. Psychiatric discharges against medical advice. Arch Gen Psychiatry 1963;8:117–9.

7. Fiscella K, Medrum S, Barnett S. Hospital discharge against advice after myocardial infarction: deaths and readmissions. Am J Med 2007;120:1047–53.

8. Manoucherhri J, Goodarzynejad H, Khoshgoftar Z, Fathollahi MS, Abyaneh MA. Discharge against medical advice among inpatients with heart disease in Iran. J Tehran Heart Cent 2012;7:72–7.

9. Onukwugha E, Saunders E, Mullins CD, et al. A qualitative study to identify reasons for discharges against medical advice in the cardiovascular setting. BMJ Open 2012;2:e000902.

10. Zhang P. Study of anxiety/depression in patients with coronary heart disease after percutaneous coronary intervention. Cell Biochem Biophys 2015;72:503–7.

11. Lasser K, Boyd W, Woolhandler S, Himmelstein DU, McCormick D, Bor DH. Smoking and mental illness: a population-based prevalence study. JAMA 2000;284:2606–10.

12. Regier DA, Farmer ME, Rae DS, et al. Comorbidity of mental disorders with alcohol and other drug abuse. JAMA 1990;264:2511–8.

13. Stearns CR, Bakamjian A, Sattar S, Weintraub MA. Discharges against medical advice at a county hospital: provider perceptions and practice. J Hosp Med 2017;12:11–7.

14. Ding R, Jung JJ, Kirsch TD, Levy F, McCarthy ML. Uncompleted emergency department care: Patients who leave against medical advice. Acad Emerg Med 2007;14:870–6.

15. Edwards J, Markert R, Bricker D. Discharge against medical advice: how often do we intervene? J Hosp Med 2013;8:574–7.

16. Garland A, Ramsey CD, Fransoo R, et al. Rates of readmission and death associated with leaving against medical advice: a population-based study. CMAJ 2013;185:1207–14.

17. Grall S, Biere L, Le Nezet M, et al. Relationship between beta-blocker and angiotensin-converting enzyme inhibitor dose and clinical outcome following acute myocardial infarction. Circ J 2015;79:632–40.

KEY WORDS discharge against medical advice, percutaneous coronary intervention, readmissions

APPENDIX For an expanded Methods section and supplemental tables, please see the online version of this paper.