Day of Discharge Does Not Impact Hospital Readmission After Major Cardiac Surgery

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Background Because the rate of rehospitalization after major cardiac surgery has been reported up to 22 , an investigation of potential modi able elements in the discharge process has led our group to evaluate whether the day of discharge affects readmission performance.

Methods Our institutional Society of Thoracic Surgeons registry was used to identify all adult patients undergoing elective cardiac operations from 2008 to 2016. Emergency, transplant, and mechanical assist patients were excluded. The primary outcome was all-cause readmission within 30 days of operation. Multivariable logistic regression was used to develop a risk-adjusted predictive model of readmission risk.

Results Of 4,877 patients discharged from our institution, 20 were discharged on a weekend or holiday. The overall rehospitalization rate was 11.3 , with comparable readmission rates for weekday and weekend and holiday discharges (11.4 vs 10.9, p 0.73). A greater proportion of patients are discharged to facilities on weekdays than on weekends and holidays (15.0 vs 5.7 , p 0.001). Discharge to a facility is associated with a higher all-cause, unadjusted readmission rate (16.7 vs 12.7 , p 0.01). After adjusting for patient comorbidities, operative performance, and postoperative complications, weekend or holiday discharge is not associated with worse readmission performance (adjusted odds ratio, 1.0; 95 con dence interval, 0.77 to 1.32).

Conclusions Cardiac surgical patients in the weekend and holiday discharge cohort did not have signi cantly higher odds of readmission regardless of operative type and discharge disposition. Allocation of resources to changing weekend staf ng may be better allocated to surgical site infection prevention and outpatient intervention programs.

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The Hospital Readmissions Reduction Program enacted by the Centers for Medicare and Medicaid Services encourages hospitals to reduce unplanned rehospitalizations [1, 2]. Although the validity of readmission performance as a metric for quality is widely debated, studies have demonstrated increased morbidity and diminished quality of life after readmission [3–5]. Furthermore, Centers for Medicare and Medicaid Services penalties for excess readmissions will encompass additional surgical interventions and conditions beyond the categories enacted in the preliminary program to eventually include coronary artery bypass grafting [6].

Readmission after cardiac surgery occurs in 8% to 22% of patients and presents a major burden to patients and health care institutions alike [7, 8]. Several studies have shown that advanced age, female sex, history of chronic lung disease, nonwhite race, and psychiatric illness are associated with increased rehospitalization after coronary artery bypass grafting [9–13]. Some groups have proposed lack of social support to be a direct risk factor for readmission, but socioeconomic status has not been broadly accepted as such [14–19]. Hospital discharge is an intricate and dynamic process requiring choreography of patients, physicians, ancillary staff, and outpatient caregivers. The demand for increasing hospital accountability for the transition of care from the inpatient to outpatient setting warrants further analysis of in uences beyond patient comorbidity and socioeconomic status that affect readmission performance.

Furthermore, many of the factors already associated with readmission cannot be readily modified. Applying principles of the weekend effect" to the discharge process after cardiac surgery may provide an alternative approach to readmission reduction [20, 21]. The weekend effect phenomenon, which has been used to describe higher mortality in myocardial infarction, stroke, and cardiac arrest admissions that occur on the weekend or at night, has been attributed to lower staffing levels and higher physician turnover on off-hours [22–25]. Given the strong correlation between weekend admissions and outcomes after common conditions, we aimed to investigate whether such differences in staffing from the usual weekday routine would affect the discharge process for

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cardiac surgical patients. Understaffing and discharge by covering physicians may result in the delivery of insufficient discharge instructions and medication reconciliation in the context of decreased access to outpatient clinics and pharmacies on weekends. Thus, the present study was performed to assess whether patients discharged on weekend or holidays after elective adult cardiac operations incurred a higher than expected 30-day readmission rate. We hypothesized that patients discharged after a cardiac operation may also be vulnerable to this weekend effect phenomenon when transitioning from inpatient to outpatient care.

Patients and Methods

The University of California, Los Angeles Institutional Review Board approved this study. Prospectively maintained data from our institutional The Society of Thoracic Surgeons Adult Cardiac Surgery database was used to identify all patients aged older than 18 years who underwent a cardiac operation between January 2008 and December 2016. The study excluded patients who had emergent/urgent, transplant, ventricular assist device, or extracorporeal membrane oxygenation support procedures to reduce heterogeneity and enhance generalizability of results to typical surgical practices.

Patients were categorized into weekday versus weekend and holiday discharges. Weekday discharges were defined as any discharge occurring Monday to Friday, excluding holidays and weekend discharges as any discharge occurring on Saturday, Sunday, or any Federal holiday. Federal holidays were identified using the isHoliday" feature of R software (R Development Core Team, Vienna, Austria).

Baseline demographics included age, sex, body mass index, New York Heart Association Functional Classification, and several other clinically relevant characteristics (Table 1). Low preoperative and postoperative ejection

Table 1. Patient Comorbidities, Perioperative Events, Discharge Disposition Associated With 30-Day Readmission

Variable	Not Readmitted (n 4,326)	Readmitted (n 551)	Overall (N 4,877)	*p* Value
Age ≥65 years, %	51.8	53.0	52.0	0.605
Male sex, %	66.0	64.4	65.9	0.452
Cigarette use, %	28.8	33.8	29.4	0.017
Racial minority, %	14.0	12.0	13.7	0.203
Diabetes, %	26.5	32.5	27.2	0.003
History of cerebrovascular disease, %	12.9	14.0	13.0	0.470
Preoperative dialysis, %	5.5	8.7	5.8	0.002
Chronic lung disease, %	14.8	18.7	15.2	0.015
Preoperative -blocker use, %	58.7	64.8	59.4	0.006
Preoperative warfarin use, %	7.5	12.2	8.0	0.001
Extubation within 6 hours, %	41.2	35.0	40.5	0.005
Aortic cross-clamp time, mean minutes	115	117	115	0.51
Reoperation for				
Any reason, %	4.6	5.8	4.8	0.220
Bleeding, %	3.1	4.4	3.3	0.133
Valve, %	0.2	0.2	0.2	0.986
Graft failure, %	0.1	0.0	0.1	0.425
Other, %	1.5	1.8	1.6	0.610
Discharged with antiarrhythmic, %	18.2	23.1	18.7	0.006
Discharged with warfarin, %	36.9	42.1	37.5	0.025
Any complication, %	35.8	47.7	37.2	0.0001
Postoperative				
Atrial fibrillation, %	14.7	20.7	15.4	0.0001
Sepsis, %	0.3	0.7	0.3	0.08
Renal failure, %	1.6	2.4	1.7	0.21
Stroke, %	1.0	0.9	1.0	0.77
Surgical site infection, %	0.3	1.8	0.5	0.001
Cardiac arrest, %	1.1	1.3	1.1	0.78
Pleural effusion, %	1.8	3.6	2.0	0.00
Depressed ejection fraction (≤0.35), %	2.6	5.1	2.9	0.00
Prolonged length of stay, %	35.7	50.5	37.3	0.0001
Weekend holiday, %	19.7	19.1	19.6	0.7
Discharge to home, %	84.6	80.94	84.15	0.03
Discharged to facility,[a] %	12.7	16.7	13.18	0.01

[a] Includes rehabilitation facility, intermediate hospital, or nursing home.

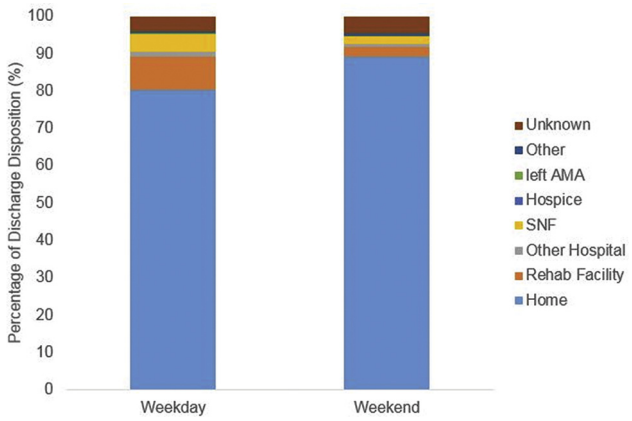

Fig 1. Discharge disposition by day of discharge. Proportion of discharges to each potential disposition location for weekday and weekend discharges. Patients in the weekend or holiday cohort have increased discharge to home, whereas the Weekday cohort have higher rates of discharge to skilled nursing facilities SNF). AMA against medical advice.)

fraction was categorized as an ejection fraction of 0.35 or less. Intraoperative variables included type of operation and aortic cross-clamp times. The primary outcome was the 30-day all-cause readmission rate. Secondary outcomes included index hospitalization mortality and occurrence of major adverse events, including prolonged ventilatory support, postoperative atrial fibrillation, stroke or transient ischemic attack, renal failure, surgical site infection, sepsis, and reoperation for any reason. All patient data, including demographics, perioperative data, and postoperative events, as defined by The Society of Thoracic Surgeons, were retrieved from the institutional database [26]. Prolonged length of stay was defined as hospitalization longer than the median duration (≥9 days).

Statistical analyses were performed using Stata 15.0 software (StataCorp, College Station, TX). We used χ^2 analysis of categorical variables and the Student *t* test of means to identify correlations between variables and the primary outcome. A multivariable logistic model predicting 30-day readmission was constructed using significant univariate interactions and clinically relevant factors. Model fit was tested using receiver operating characteristic curves. Statistical significance was determined at *p* values of less than 0.05.

Results

Between January 2008 and December 2016, 6,061 patients underwent cardiac operations at our institution and were available for consideration in this study. After application of exclusion criteria, 4,877 patients survived index hospitalization, of whom 19.6% were discharged on a weekend or holiday. Cumulative in-hospital mortality was 2.5%, while 11.3% were readmitted within 30 days. Compared with the overall cohort, readmitted patients had a higher prevalence of current tobacco abuse, diabetes, preoperative renal failure requiring dialysis, chronic lung disease, use of -blockers and warfarin, surgical site infection, postoperative pleural effusion requiring intervention, and postoperative atrial fibrillation (Table 1). Patients requiring rehospitalization had lower rates of extubation within 6 hours postoperatively (35% vs 40%, *p* 0.012) and experienced a longer length of stay (10.9 days vs 9.4 days, *p* 0.0002). Intraoperative variables such as aortic cross-clamp time were not significantly associated with 30-day readmission. Postoperative complications, such as atrial fibrillation, pleural effusions, surgical site infections, were more prevalent in the readmitted cohort (Table 1).

Of all patients who survived to discharge, 84.2% were discharged to home, and 13.2% were transferred to an acute rehabilitation, intermediate hospital, or nursing home facility. The proportion of patients discharged to a facility other than home was significantly greater in the readmitted cohort than in patients who were not rehospitalized within 30 days (16.7% vs 12.7%, *p* 0.001; Table 1). Thus, the rate of readmission for patients discharged to a facility was significantly higher (14.3% vs 10.8%, *p* 0.01).

Weekday Versus Weekend and Holiday Discharge

Overall, nearly 20% of all discharges occurred on weekends and holidays, with no significant difference in the weekend and holiday discharge proportion for patients who were readmitted (19.1%) compared with those who were not (19.7%, *p* 0.73). Given that discharge destination was associated with the readmission rate, we examined the differences in facility discharge by day of discharge (Fig 1). Within our institutional data, patients were discharged to a rehabilitation/skilled nursing facility more often on weekdays (15.0% vs 5.7%, *p* 0.001) and more often home on the weekend and holidays (82.3% vs 92.4%, *p* 0.001; Table 2). Beyond differences in discharge destination, the weekday cohort had a greater proportion of current tobacco use, history of cerebrovascular disease, chronic lung disease, postoperative stroke, and prolonged length of stay. Among the two discharge cohorts there was no statistically significant difference between index reoperation rates and depressed postoperative ejection fraction (Table 2). Unadjusted 30-day readmission rates were similar between the weekend and holiday cohort and the weekday cohort (11.4% vs 11.0%, *p* 0.73).

After adjusting for baseline differences using a multivariable model with a final C-statistic of 0.68, current tobacco use (adjusted odds ratio [AOR], 1.3; 95% confidence interval [CI], 1.1 to 1.7; *p* 0.02,), use of preoperative -blockers (AOR, 1.3; 95% CI, 1.04 to 1.66; *p* 0.02), deep or superficial surgical site infection (AOR, 5.1; 95% CI, 2.1 to 12.8; *p* 0.001), and low postoperative ejection fraction (AOR, 1.9, 95% CI, 1.1 to 3.1; *p* 0.013,) were associated with increased risk-adjusted odds of readmission. In contrast, nonhome discharge (AOR, 1.1; 95% CI, 0.85 to 1.5; *p* 0.36) was not associated with increased readmission (Table 3). Thus, after accounting for additional variables, weekend and holiday discharge was not

Table 2. Patient Comorbidities, Perioperative Events, Discharge Disposition, Readmission by Day of Discharge

Variable	Weekday (n 3,921) (%)	Weekend/Holiday (n 956) (%)	Overall (N 4,877) (%)	*p* Value
Age ≥65 years	52.61	49.27	51.96	0.06
Male sex	65.24	68.41	65.86	0.06
Cigarette use	30.07	26.57	29.38	0.03
Racial minority	14.15	12.03	13.74	0.09
Diabetes	27.19	26.99	27.15	0.90
History of cerebrovascular disease	13.64	10.36	13.00	0.01
Preoperative dialysis	5.94	5.33	5.82	0.47
Chronic lung disease	16.22	10.98	15.19	0.0001
Preoperative -blocker use	59.32	59.62	59.38	0.87
Preoperative warfarin use	8.01	8.16	8.04	0.88
Extubation within 6 hours	39.22	45.82	40.52	0.001
Reoperation for				
Any reason	4.77	4.71	4.76	0.94
Bleeding	3.32	3.14	3.28	0.78
Valve	0.15	0.31	0.18	0.30
Graft failure	0.10	0.10	0.10	0.98
Other	1.56	1.57	1.56	0.98
Discharge with antiarrhythmic	18.90	17.99	18.72	0.52
Discharge with warfarin	37.35	37.90	37.46	0.77
Any complication	38.66	31.07	37.17	0.0001
Postoperative				
Atrial fibrillation	15.63	14.44	15.40	0.36
Sepsis	0.38	0.10	0.33	0.18
Renal failure	1.86	1.05	1.70	0.08
Stroke	1.22	0.21	1.03	0.01
Surgical site infection	0.46	0.42	0.45	0.87
Cardiac arrest	1.17	1.05	1.15	0.74
Pleural effusion	2.14	1.26	1.97	0.08
Depressed ejection fraction (≤0.35)	2.88	2.82	2.87	0.92
Prolonged length of stay	38.84	31.17	37.34	0.0001
Discharge home	82.15	92.36	84.15	0.0001
Discharge not home	15.02	5.65	13.18	0.0001
Readmitted	11.37	10.98	11.3	0.732

associated with an increased adjusted risk of readmission (Table 3). On subgroup analysis of different operation types (ie, valve vs coronary artery bypass grafting) and discharge destinations (Table 3), there was no significant association between weekend and holiday discharge and readmission within 30 days. Furthermore, among active smokers (AOR, 1.55; 95% CI, 1.0 to 2.42; p 0.05) and patients on preoperative -blockade (AOR, 0.97; 95% CI, 0.70 to 1.35; p 0.87) weekend and holiday discharge did not have increased odds of readmission.

Indications for Readmission After Primary Operation

For this patient population, 38% of all readmissions were related to the primary operation without additional specificity, and 16.7% were not related to the cardiac operation. Cardiac disorders comprised 20.1% (Fig 2). Among cardiac readmissions, arrhythmia/heart block was most common (10%), and pericardial effusion or tamponade and heart failure comprised 4.3% and 3.9%, respectively (Table 4). When the readmission diagnoses by day of discharge were compared, more patients who returned with pericardial effusion or tamponade after discharge were part of the weekday cohort (58.3% vs 41.7%, p 0.007). All other readmission diagnoses had comparable distributions.

Comment

Care coordination and seamless transition from inpatient to outpatient care have been emphasized as means of reducing hospital readmissions, a surrogate marker for quality of care. Cardiac surgical patients often have a number of comorbidities that predispose them to readmission. Discharge planning for cardiac surgical patients requires intensive management of patient comorbidities, frailty, and postoperative issues. We were interested in determining whether the relative lack of hospital resources during weekends and holidays would lead to increased readmission rates. If true, holding weekend discharges of cardiac surgical patients may serve to

Table 3. Adjusted Odds Ratio of Readmission Within 30 Days Overall and Discharge Disposition

Variable	All Patients	*p* Value	Discharge to Home	*p* Value	Discharge to Facility	*p* Value
Age ≥65 years	0.94	0.60	0.95	0.65	1.13	0.73
Male sex	0.83	0.10	0.78	0.05	1.15	0.62
Racial minority	0.86	0.35	0.95	0.79	0.24	0.02
Cigarette use	1.33	0.01	1.29	0.06	1.63	0.08
Pre-op -blocker	1.32	0.02	1.31	0.04	1.18	0.59
Pre-op dialysis	1.44	0.07	1.70	0.02	0.93	0.88
Cerebrovascular disease	1.11	0.48	1.07	0.69	1.52	0.18
Peripheral vascular disease	0.93	0.70	0.92	0.72	1.11	0.78
Chronic lung disease	1.09	0.60	1.21	0.31	0.67	0.33
Liver disease	1.15	0.60	1.24	0.45	0.33	0.30
Diabetes	1.20	0.13	1.13	0.37	1.59	0.10
Pre-op arrhythmia/atrial fibrillation	1.12	0.17	1.15	0.10	0.96	0.87
Cross-clamp time	1.00	0.69	1.00	0.26	1.00	0.15
Extubated 6 hours	0.83	0.10	0.89	0.35	0.66	0.21
Prolonged length of stay	1.25	0.07	1.34	0.04	0.83	0.54
Intraaoartic balloon pump	1.05	0.84	1.32	0.29	0.38	0.14
Any complication	1.23	0.16	1.17	0.37	1.52	0.24
Post-op atrial fibrillation	1.11	0.50	1.14	0.48	1.21	0.58
Post-op cardiac arrest	0.65	0.34	0.73	0.58	0.22	0.16
Surgical site infection	5.31	0.001	8.05	0.00	2.74	0.29
Pleural effusion	1.62	0.09	1.71	0.13	2.08	0.22
Post-op renal failure	0.60	0.23	1.24	0.64	—	—
Septicemia	1.12	0.87	1.68	0.58	0.56	0.61
Low post-op ejection fraction (≤0.35)	1.96	0.01	2.02	0.01	2.29	0.20
Weekend/holiday	1.01	0.95	1.02	0.90	1.06	0.90
Reoperation for any cardiac indication	0.85	0.51	0.82	0.49	1.13	0.81
Discharge other than home	1.15	0.36	—	—	—	—
C statistic	0.63		0.63		0.71	

Post-op postoperative; pre-op preoperative.

reduce readmission rates. In this retrospective single-institution study of patients undergoing elective major cardiac operations, weekend or holiday discharge was not associated with worse readmission performance after adjusting for patient comorbidities and intraoperative variables. Use of preoperative -antagonist medications, tobacco use, and surgical site infections were independent predictors of rehospitalization within 30 days.

Debate regarding the complement of patient and hospital factors that increase the risk of readmission continues for a wide array of medical and surgical conditions. Comorbidities historically implicated in worse readmission performance, specifically after cardiac operations, such as advanced age, chronic lung disease, dialysis dependence, postoperative pleural effusion, and neurologic complications, were not significant in our patient population [9–12]. The present study also demonstrated a higher risk of readmission associated with current tobacco use and preoperative -blocker medications. Use of -blockers may represent an otherwise uncaptured burden of cardiovascular disease and explain this paradox.

The burden is on the health care system to implement preoperative optimization and postoperative care programs to address these patients with a higher risk for rehospitalization. Furthermore, patients who were readmitted in the present study had slightly longer length of stay, which may not be clinically relevant. This is in contrast to several studies in the heart failure and surgical literature that have shown shorter hospitalization duration is associated with increased readmission [27]. This discrepancy likely represents the fact that patients with prolonged hospital stay likely suffered from additional complications or were physiologically unfit to be discharged, thereby increasing their risk for readmission.

Other studies have reported increased mortality with weekend or after-hour hospitalizations in stroke and myocardial infarction [22–25]. However, few have examined weekend discharge and its effect on post-surgical patient readmissions. Cloyd and colleagues [28] studied the relationship between weekend discharge and outcomes after colectomy, abdominal aortic aneurysm repair, hip arthroplasty, and pancreatectomy and found no general association with day of discharge. Rather, they found that colectomy patients discharged on weekends had fewer readmissions [28]. Finally, a study of nonsurgical patients admitted to an internal medicine service observed no correlation between weekend discharge and readmission rates [29]. To the

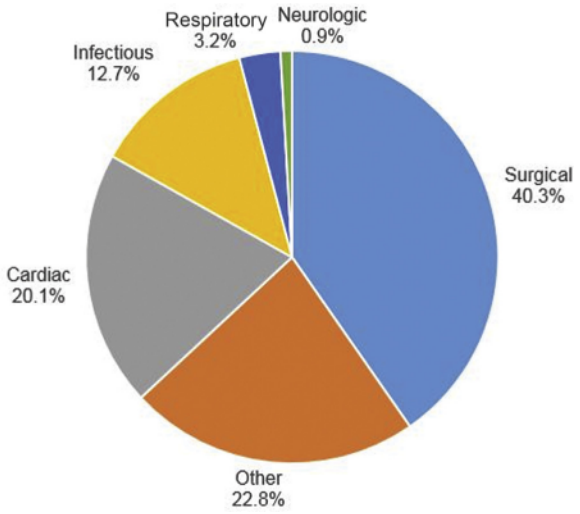

Fig 2. Readmission diagnoses by categories de ned by The Society of Thoracic Surgeons readmission reasons. Surgical reasons for readmission, such as pharmacologic anticoagulation complication, vascular complication, coronary artery graft, or valve dysfunction or related admission, were the most common indications for readmission. Cardiac arrhythmia, pericardial effusion, congestive heart failure exacerbation, recurrent myocardial infarction/angina, or pulmonary embolism), followed by infectious pneumonia, infection of conduit harvest site, infection deep sternum/mediastinitis) and respiratory pleural effusion, other respiratory) complications were the next three most common categories for readmission beyond the unspeci ed other" category.

Table 4. Readmission Diagnoses for Each Category

Readmission Diagnosis	Readmissions (n 558) (%)
Cardiac	20.7
Arrhythmia/heart block	10.04
Pericardial effusion/tamponade	4.3
Heart failure	3.0
Myocardial infarction/recurrent angina	1.1
Pulmonary embolus	0.72
Respiratory	3.3
Pleural effusion requiring intervention	2.2
Respiratory complication, other	1.1
Renal failure	0.36
Surgical	4.0
Vascular complication	0.7
Anticoagulation-related complication	1.43
Coronary artery/graft dysfunction	0.18
Valve dysfunction	0.18
Related readmission	37.8
Neurologic	0.1
Transient ischemic attack	0.54
Stroke	0.36
Infectious	12.7
Pneumonia	9.5
Infection of conduit harvest site	1.6
Infection deep sternum/mediastinitis	1.6
Other	22.8
Other planned readmission	1.25
Other nonrelated readmission	16.7
Unknown	3.2

best of our knowledge, our study of cardiac surgical patients at a tertiary care urban medical center concurs with the day of discharge literature but offers novel patient comorbidities not previously considered as risk factors for worse readmission performance [4–6].

Implementation of multidisciplinary care coordination efforts at our institution, with proactive discharge education, detailed medication instructions, and in some instances, telehealth visits, may explain why weekend or holiday discharge had no effect on rates of rehospitalization [30]. Based on previous work from our group, patients who were called by a member of the care team within 48 hours of discharge and every 4 to 5 days for 30 days benefited from improved access to expert advice after their hospitalization [30]. System interventions integrated in our practice may have mitigated the weekend effect on patient outcomes. Large randomized trials of telehealth visits are scarce in cardiac surgery and are warranted to determine which elements of the discharge process have the greatest effect on patient outcomes.

This study has several limitations inherent to its retrospective nature. Because randomization of discharge time was not practical, we attempted to perform a comprehensive regression model to minimize bias and account for inherent differences in the weekday and weekend discharge cohorts. Furthermore, this study represents the outcomes of a single academic institution, limiting the generalizability of the results. Nonetheless, we have demonstrated that the use of the present resources and a patient-centered readmission reduction program using existing hospital resources could minimize any potential effect from weekend and holiday discharge.

Inability to characterize costs and length of stay of readmission episodes was an additional limitation of this investigation. The study follow-up duration of 30 days also prevents capture of intermediate and late-stage readmissions. Assessment of whether readmissions occurred at index or nonindex institutions was not possible.

Furthermore, community-based readmission prevention programs were not included in this study. Future research should be aimed at patient factors and community-based interventions to continue to mitigate patient morbidity and hospital costs associated with readmission. Benbassat and Taragin [31] conducted a meta-analysis suggesting that to reduce hospital readmissions, one needed to include community-based services, which have been shown to be integral in reducing readmission rates in patients with chronic disease. In patients with heart failure, community interventions such as structured telephone support, home visits, and pharmacist care, were shown to reduce readmissions [31]. Randomized assessment of these community-based interventions and protocols may provide a target for future efforts to reduce health care spending and readmission.

In summary, weekend discharge did not appear to increase rates of hospital readmission after cardiac operations. Delaying weekend discharges is unlikely to confer a beneficial reduction in readmission rates. Given this finding, hospital readmission reduction programs should focus on identifying patients with known risk factors for readmission rather than expanding existing weekend staff coverage.

References

1. Patient Protection and Affordable Care Act. Public Law No. 111–148. March 23, 2010. 124 Stat. 119. Available at https://www.congress.gov/111/plaws/publ148/PLAW-111publ148.pdf. Accessed November 18, 2017.
2. Zhang DJ, Gurvich I, Van Mieghem JA, Park E, Young RS, Williams MV. Hospital readmissions reduction program: an economic and operational analysis. Manage Sci 2016;62:3351–71.
3. Dimick JB, Ghaferi AA. Hospital readmission as a quality measure in surgery. JAMA 2015;313:512–3.
4. Fontanarosa PB, McNutt RA. Revisiting hospital readmissions. JAMA 2013;309:398–400.
5. Courtney M, Edwards H, Chang A, Parker A, Finlayson K, Hamilton K. Fewer emergency readmissions and better quality of life for older adults at risk of hospital readmission: a randomized controlled trial to determine the effectiveness of a 24-week exercise and telephone follow-up program. J Am Geriatr Soc 2009;57:395–402.
6. Jencks SF, Williams MV, Coleman EA. Rehospitalizations among patients in the Medicare Fee-for-Service Program. N Engl J Med 2009;360:1418–28.
7. Hannan EL, Racz MJ, Walford G, et al. Predictors of readmission for complications of coronary artery bypass graft surgery. JAMA 2003;290:773–80.
8. Hannan EL, Zhong Y, Lahey SJ, et al. 30-day readmissions after coronary artery bypass graft surgery in New York State. JACC Cardiovasc Interv 2011;4:569–76.
9. Iribarne A, Chang H, Alexander JH, et al. Readmissions after cardiac surgery: experience of the National Institutes of Health/Canadian Institutes of Health Research Cardiothoracic Surgical Trials Network. Ann Thorac Surg 2014;98:1274–80.
10. Kilic A, Magruder JT, Grimm JC, et al. Development and validation of a score to predict the risk of readmission after adult cardiac operations. Ann Thorac Surg 2017;103:66–73.
11. Sibilitz KL, Berg SK, Thygesen LC, et al. High readmission rate after heart valve surgery: a nationwide cohort study. Int J Cardiol 2015;189:96–104.
12. van Diepen S, Graham MM, Nagendran J, Norris CM. Predicting cardiovascular intensive care unit readmission after cardiac surgery: derivation and validation of the Alberta Provincial Project for Outcomes Assessment in Coronary Heart Disease (APPROACH) cardiovascular intensive care unit clinical prediction model from a registry cohort of 10,799 surgical cases. Crit Care 2014;18:651.
13. Tully PJ, Baker RA. Depression, anxiety, and cardiac morbidity outcomes after coronary artery bypass surgery: a contemporary and practical review. J Geriatr Cardiol 2012;9:197–208.
14. van Walraven C, Austin PC, Jennings A, Quan H, Forster AJ. A modification of the Elixhauser comorbidity measures into a point system for hospital death using administrative data. Med Care 2009;47:626–33.
15. Kind AJH, Smith MA, Frytak JR, Finch MD. Bouncing back: patterns and predictors of complicated transitions 30 days after hospitalization for acute ischemic stroke. J Am Geriatr Soc 2007;55:365–73.
16. Damiani G, Salvatori E, Silvestrini G, et al. In uence of socioeconomic factors on hospital readmissions for heart failure and acute myocardial infarction in patients 65 years and older: evidence from a systematic review. Clin Interv Aging 2015;10:237–45.
17. Van Walraven C, Oake N, Jennings A, Forster AJ. The association between continuity of care and outcomes: a systematic and critical review. J Eval Clin Pract 2010;16:947–56.
18. Kangovi S, Grande D. Hospital readmissions—not just a measure of quality. JAMA 2011;306:1796–7.
19. Strunin L, Stone M, Jack B. Understanding rehospitalization risk: can hospital discharge be modified to reduce recurrent hospitalization? J Hosp Med 2007;2:297–304.
20. Becker DJ. Do hospitals provide lower quality care on weekends? Health Serv Res 2007;42:1589–612.
21. Bell CM, Redelmeier DA. Mortality among patients admitted to hospitals on weekends as compared with weekdays. N Engl J Med 2001;345:663–8.
22. Nanchal R, Kumar G, Taneja A, et al. Pulmonary embolism. Chest 2012;142:690–6.
23. Groves EM, Khoshchehreh M, Le C, Malik S. Effects of weekend admission on the outcomes and management of ruptured aortic aneurysms. J Vasc Surg 2014;60:318–24.
24. Aujesky D, Jimenez D, Mor MK, Geng M, Fine MJ, Ibrahim SA. Weekend versus weekday admission and mortality after acute pulmonary embolism. Circulation 2009;119:962–8.
25. Kostis WJ, Demissie K, Marcella SW, et al. Weekend versus weekday admission and mortality from myocardial infarction. N Engl J Med 2007;356:1099–109.
26. The Society of Thoracic Surgeons. STS Adult Cardiac Surgery Database Data Collection Forms, Version 2.9, 2017. Available at https://www.sts.org/registries-research-center/sts-national-database/adult-cardiac-surgery-database/data-collection. Accessed November 15, 2017.
27. Sud M, Yu B, Wijeysundera HC, et al. Associations between short or long length of stay and 30-day readmission and mortality in hospitalized patients with heart failure. JACC Heart Fail 2017;5:578–88.
28. Cloyd JM, Chen J, Ma Y, Rhoads KF. Association between weekend discharge and hospital readmission rates following major surgery. JAMA Surg 2015;150:849–56.
29. McAlister FA, Youngson E, Padwal RS, Majumdar SR. Similar outcomes among general medicine patients discharged on weekends. J Hosp Med 2015;10:69–74.
30. McElroy I, Sareh S, Zhu A, et al. Use of digital health kits to reduce readmission after cardiac surgery. J Surg Res 2016;204:1–7.
31. Benbassat J, Taragin MI. The effect of clinical interventions on hospital readmissions: a meta-review of published meta-analyses. Isr J Health Policy Res 2013;2:1.