

Discharge Before Noon: Is the Sun Half Up or Half Down?

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Crowding in emergency departments (EDs) and inadequate hospital capacity are the new norm. Results of multiple studies suggest that overcrowding has deleterious effects, which can be seen as a threat to public health.¹⁻⁹ A large body of research has focused on means and strategies that reduce crowding in the ED.¹⁰⁻¹² One tactic is to increase the number of hospital discharges earlier in the day because late afternoon discharges create admission bottlenecks in the ED. To this end, many health care institutions have focused efforts on discharging patients earlier in the day.¹³⁻¹⁵ Some consider it best practice to discharge patients before noon.

This strategy may lead to an improvement in ED flow, but its impact on the length of stay (LOS) and readmission rates of hospitalized patients is unclear.¹⁶ If clinicians are incentivized to discharge patients before noon, there could be a motivation to keep patients who could be discharged later in the day until the next morning, thereby increasing their LOS. In addition, if clinicians rush patients to be discharged before noon, it is possible that not all the measures that would prevent a readmission (eg, medication reconciliation, primary care provider appointment, discharge education) would be firmly in place for short-stay patients. It is not common to have a standardized, reliable, hardwired process for discharge planning on admission for longer lengths of stay, which increases the likelihood of a rushed discharge.

A few studies have analyzed the impact of discharge before noon (DBN) on the LOS of hospitalized patients. One retrospective analysis from a single academic center looking at discharged adult patients found that patients discharged before noon tended to have a higher LOS.¹⁷ However, in another report done in adults, LOS was shown to be decreased overall.¹⁴ In pediatric patients, a study found that patients who were discharged before noon had a lower LOS in medical but not surgical cases.¹⁸ Due to the ambivalence of findings and recent changes in the health care landscape (eg, the 2-midnight rule, a rule implemented by CMS that allows physicians to admit patients on inpatient status to the hospital based on the assumption that the medical care required will exceed 2 midnights), we sought to reevaluate the impact of DBN on LOS and readmission of adult inpatients.

ABSTRACT

OBJECTIVES: To analyze the impact of discharge before noon (DBN) on length of stay (LOS) and readmission of adult inpatients.

STUDY DESIGN: Retrospective analysis of 78,826 patients from a single tertiary care center between January 1, 2016, and December 31, 2018.

METHODS: The patient population was divided between patients discharged before and after noon. Outcomes were analyzed with univariate and multivariate analyses.

RESULTS: DBN was independently associated with higher likelihood of LOS above the median [odds ratio [OR], 1.26; 95% CI, 1.18-1.35; $P < .001$] among medical patients. This association was not seen among surgical patients, in whom DBN was associated with a shorter LOS [OR, 0.78; 95% CI, 0.71-0.86; $P < .001$]. Factors associated with higher LOS in both medical and surgical groups included higher case mix index, Medicaid payer, weekday discharges, and discharge to skilled nursing or rehabilitation facilities. For the variable of readmission, DBN in surgical patients was associated with a lower readmission rate [OR, 0.81; 95% CI, 0.69-0.95; $P = .008$].

CONCLUSIONS: The finding that DBN was associated with higher LOS among medical patients suggests that some patients may have been able to be safely discharged the evening prior. In patients with surgical diagnoses, DBN was associated with a lower LOS and a lower risk of readmission. Patients with later discharges were more likely to be sent to a rehabilitation center or skilled nursing facility and were more frequently discharged during a weekday. Identification of these factors may help health systems transition patients safely and efficiently out of the hospital.

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METHODS

Study Design and Inclusion Criteria

We performed a retrospective study of all inpatients discharged from our institution, Cooper University Hospital, between January 1, 2016, and December 31, 2018. Our institution is a tertiary academic medical center in Camden, New Jersey. It has 600 licensed beds and is a level 1 trauma center. We serve the southern New Jersey area and admit patients from our ED, as transfers from other institutions, and as direct admissions from outpatient centers.

Only inpatients were included in the study. If a patient was admitted as observation status but changed to inpatient status, they were included in the analysis.

Services were divided into medical, surgical, and other. The “other” category encompassed patients on services including neurology, obstetrics and gynecology (OB/GYN), maternal-fetal medicine, psychiatry, anesthesia, cardiology, critical care, infectious disease, and pulmonary.

We extracted the following variables from the administrative database: age, gender, race, admission date and time, discharge date and time, discharging team, diagnosis-related group (DRG) type, case mix index (CMI), 30-day readmission, LOS, discharge destination, and payer.

Patients excluded from the readmission algorithm included those who had died, those who were transferred to another acute care facility, and those who left against medical advice (AMA).

Outcomes and Definitions

DBN was defined as a patient leaving the hospital between 00:01 and 11:59. Discharge after noon (DAN) was defined as discharges between 12:00 and 23:59.

Insurance was divided into primarily Medicare, Medicaid, private insurance, or other. “Other” insurance was defined as charity care, self-pay, other government payers, and unknown.

We looked at 2 main outcomes, LOS and readmissions. The LOS was calculated as day of discharge minus day of admission. For the readmission outcome, we looked at the actual readmission within 30 days to our institution. We used the CMI as a proxy for severity of illness.¹⁹

Statistical Analysis

Categorical data are presented as percentages; continuous data are presented as mean (SD). The population was subdivided between DBN and DAN. We used χ^2 analysis, Mann-Whitney U tests, and *t* tests to assess for differences between variables, as appropriate. We analyzed the association among DBN status, LOS, and readmissions.

We used 2 methods to assess for the independent association of DBN on the outcomes of interest: a multivariate logistic regression model and the analysis of the observed over expected (O/E) rates.

TAKEAWAY POINTS

Many hospitals have focused on discharging patients before noon as a goal to improve throughput and length of stay (LOS). We analyzed the impact of discharge before noon (DBN) on LOS and readmissions.

- ▶ DBN was independently associated with higher LOS among medical patients but not among surgical patients.
- ▶ DBN was associated with lower readmission risk in surgical patients but not medical patients.
- ▶ These findings suggest that some patients may have been able to be safely discharged the evening prior; therefore, DBN may sometimes present a financial loss for the health system.

For those analyses, we excluded patients who died and patients who left AMA because these events would not be directly related to the medical course of the disease and their “discharge” from the facility would occur independent of time of day.

For the regression analysis, we entered the following variables in the model: age, gender, race, discharge day of the week (weekdays vs weekends), discharge diagnosis (medical vs surgical DRG), CMI, discharge destination, insurance status, and discharge time groups (DBN vs DAN). The variables age and CMI were entered as continuous and all the others as categorical. Variables were all entered simultaneously and considered significant if $P < .05$.

The LOS O/E rate is the ratio of the observed LOS to the expected LOS. The expected LOS is provided by Premier Inc, a large administrative database that represents close to 40% of patients discharged from the hospital in the United States. It uses a risk-adjusted methodology taking into account demographical and clinical variables and diagnosis, and it uses a statistical regression analysis to assign an expected LOS for patients. This database has been used by more than 508 publications to date.²⁰⁻²³ Because the expected LOS is derived from a regression analysis, we compared the values O/E in the DBN and DAN groups. Data were analyzed using SPSS 25.0 (IBM).

RESULTS

Patients and Demographics

We included 78,826 patients in our study: 25,841 patients were discharged in 2016; 26,592, in 2017; and 26,033, in 2018. A total of 8248 (10.5%) patients were discharged before noon. Demographic variables are presented in **Table 1** by discharge group: DBN and DAN. There were significant differences in groups in the following categories: age, CMI, race, discharge service, discharge diagnosis categories, discharge day of the week, insurance status, and discharge destination. There were no differences in gender and year of discharge (Table 1).

Discharge Times

The majority of the patients (75%) were discharged between 13:41 and 17:46. The median discharge time was 15:50 (**Figure**).

LOS Outcome and Readmissions: Univariate Analysis

We then looked at differences of LOS between groups. Results are presented in **Table 2**. We analyzed differences for the overall

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TABLE 1. Demographic Variables by Discharge Status

	All patients	Discharged before noon	Discharged after noon	P
Number of patients	78,826	8248 (10.5%)	70,508 (89.5%)	
Age in years, mean (SD)	54.9 (19)	50 (18.5)	55.5 (19)	<.001
Female gender, n (%)	43,534	4477 (10.3%)	39,057 (89.7%)	.166
Case mix index, mean (SD)	1.9 (1.9)	1.7 (1.9)	1.9 (1.9)	<.001
Discharge year, n (%)				
2016	25,841	2709 (10.5%)	23,132 (89.5%)	.546
2017	26,952	2856 (10.6%)	24,096 (89.4%)	
2018	26,033	2683 (10.3%)	23,350 (89.7%)	
Race, n (%)				
African American	19,986	2065 (10.3%)	17,921 (89.7%)	.033
White	41,814	4298 (10.3%)	37,516 (89.7%)	
Hispanic	12,462	1386 (11.1%)	11,076 (88.9%)	
Other or unable to obtain	4564	499 (10.9%)	4065 (89.1%)	
Service, n (%)				
Hospitalist	32,457	2678 (8.3%)	27,779 (91.7%)	<.001
Surgery	20,430	1726 (8.4%)	18,704 (91.6%)	
Other	25,939	3844 (14.8%)	22,095 (85.2%)	
Discharge diagnoses, n (%)				
Medical	48,483	5452 (11.2%)	43,031 (88.8%)	<.001
Surgical	30,343	2796 (9.2%)	27,547 (90.8%)	
Discharge day, n (%)				
Weekday	62,666	5673 (9.1%)	56,993 (90.9%)	<.001
Weekend	16,160	2575 (15.9%)	13,585 (84.1%)	
Insurance status, n (%)				
Medicare	30,754	2544 (8.3%)	28,210 (91.7%)	<.001
Medicaid	18,185	2423 (13.3%)	15,762 (86.7%)	
Insurance	25,037	2680 (10.7%)	22,357 (89.3%)	
Other	4850	601 (12.4%)	4249 (87.6%)	
Discharge destination, n (%)				
Discharge to home	60,411	6267 (10.4%)	54,144 (89.6%)	<.001
Discharge to SNF/rehabilitation	12,838	520 (4.1%)	12,318 (95.9%)	
Other discharge	1990	284 (14.3%)	1706 (85.7%)	
Died	1617	581 (35.9%)	1036 (64.1%)	
Left against medical advice	1962	594 (30.3%)	1368 (69.7%)	

SNF, skilled nursing facility.

population, by DRG (medical vs surgical), by day of the week (weekday vs weekend), and by discharge destination.

For the readmissions, only readmissions to the same institution as discharge were included in the analysis. Although patients could have been readmitted to other facilities, the data set does not allow

for these comparisons. In addition, we did not record readmission for patients who left AMA (1962 patients), were transferred to other institutions (297 patients), or died (1617 patients), for a total of 3876 patients. There were 10,268 readmissions in the population overall (13.7%).

Results for readmissions are presented in Table 2. They were conducted in subgroups similarly to the LOS analyses.

Regression Analyses

We performed regression analyses as detailed in the Methods section and analyzed the outcomes LOS and readmissions.

DBN was independently associated with higher likelihood of LOS above the median (odds ratio [OR], 1.26; 95% CI, 1.18-1.35; $P < .001$) among medical patients. This association was not seen among surgical patients, in whom DBN was associated with a shorter LOS (OR, 0.78; 95% CI, 0.71-0.86; $P < .001$). Factors associated with higher LOS in both medical and surgical groups included higher CMI, Medicaid payer, weekday discharges, and discharge to skilled nursing facility (SNF)/rehabilitation center. The greatest effect size was seen in CMI (all patients, OR, 2.23; 95% CI, 2.18-2.29) and in SNF/rehabilitation discharges (all patients, 4.24; 95% CI, 4.03-4.47) (Table 3).

For the variable readmission, DBN was associated with a lower readmission rate in surgical patients (OR, 0.81; 95% CI, 0.69-0.95; $P = .008$) but not in the population overall (OR, 0.92; 95% CI, 0.84-1.01) or in medical patients (OR, 0.94; 95% CI, 0.86-1.03). Factors associated with higher readmission in all patients included higher CMI, Medicaid insurance, and Medicare insurance (Table 4).

O/E LOS

We compared the O/E LOS between the DBN and DAN groups for the general population as well as in the subgroups with medical and surgical DRGs. For the population overall, there was no difference between DBN and DAN ($P = .630$). We found that DBN was associated with higher O/E LOS in patients with medical diagnoses (1.28 vs 1.21; $P = .002$) but lower O/E LOS in surgical patients (1.31 vs 1.39; $P = .001$). These results were concordant with those we found using the multivariate regression analysis.

DISCUSSION

Our findings show that in a population of adult hospitalized patients with medical diagnoses, DBN was associated with higher LOS (OR, 1.26; 95% CI, 1.18-1.35) and was not associated with readmission risk (OR, 0.94; 95% CI, 0.86-1.03). Patients who are medically fragile, lack access to immediate postacute care needs such as durable medical equipment, have low health literacy, lack family support, or require a higher level of coordinated ambulatory care may be kept longer to ensure that all available resources are in place. Patients requiring placement in a facility such as a rehabilitation center or SNF may face additional delays in acceptance, insurance authorization, and transportation, resulting in discharge delays. This is additionally supported by the findings of greater LOS among patients destined for

SNFs or rehabilitation centers, although these patients may also have more comorbidities and greater severity of illness, as evidenced by the finding that the CMI among those destined for SNF/rehabilitation was 2.84, whereas the CMI of all others was 1.68.

Among the surgical population, however, DBN was associated with a lower LOS (OR, 0.78; 95% CI, 0.71-0.86) and a lower readmission rate (OR, 0.81; 95% CI, 0.69-0.95). Surgical patients benefit from very well-defined clinical pathways to guide management. Those patients whose trajectories deviate from the expected course would be anticipated to have additional delays and extended inpatient management. Patients who are admitted for elective procedures but are otherwise medically stable may represent a fundamentally different subpopulation, although this was not captured in the data representation.

There were significant differences in the populations who were discharged before and after noon. Although ethnicity and gender were not associated with discharge time, patients discharged before noon tended to be younger and were less likely to be on a hospitalist service. Early discharges were more frequently seen in patients on nonhospitalist, nonsurgical services (ie, the “other” category) and resulted in a DBN occurring almost twice as frequently (14.8% of all “other” admissions) compared with the hospitalist (8.3% of all hospitalist discharges) and surgical (8.4% of all surgical discharges) groups. This group consisted of a broad range of fields, making direct interpretation of causation difficult, but future areas of inquiry can explore the reasons behind these discrepancies. The preponderance of the data showed that early discharges were on psychiatry (32.4% of psychiatry discharges) and critical care (23.7%). Other groups in this category that similarly had higher rates of early discharges included OB/GYN (16.5%), neurology (13.9%), and maternal-fetal medicine (13.0%). Critical care discharges before noon were predominantly driven by patients’ deaths. However, the inclusion of medical subspecialty fields may suggest that the patients on their service may be either well known to the subspecialists on that service, providing a degree of comfort with early discharges and planned follow-up, or less ill, with 1 major organ system being affected rather than the multiple medical problems characteristic of patients on the hospitalist services. These patients may have a more expected recovery course or be less medically ill,

FIGURE. Frequency of Discharge by Time of Day

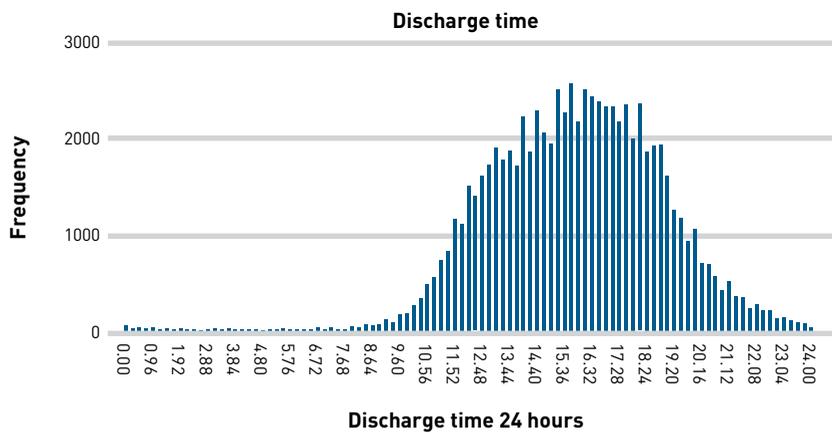


TABLE 2. Outcomes of LOS and Readmission by Discharge Status

	Total	Discharged before noon	Discharged after noon	P
All patients, n				
LOS	78,826	8248	70,508	
Readmissions analysis	74,949	7023	67,926	
LOS, mean (SD)	5.4 (7.5)	4.9 (8.3)	5.4 (7.4)	<.001
Readmissions, n (%)	10,268 (13.7%)	849 (12.1%)	9419 (13.9%)	<.001
Patients with medical DRG				
LOS, mean (SD)	4.5 (5.9)	4.3 (7.7)	4.5 (5.6)	.110
Readmissions, n (%)	7216 (15.8%)	661 (14.6%)	6555 (16.0%)	.014
Patients with surgical DRG				
LOS, mean (SD)	6.8 (9.3)	6.0 (9.2)	6.9 (9.3)	<.001
Readmissions, n (%)	3052 (10.4%)	188 (7.6%)	2864 (10.7%)	<.001
Weekday discharge				
LOS, mean (SD)	5.7 (7.9)	5.2 (9.2)	5.7 (7.7)	<.001
Readmissions, n (%)	8322 (13.9%)	606 (12.7%)	7716 (14.0%)	.011
Weekend discharge				
LOS, mean (SD)	4.3 (5.7)	4.2 (5.6)	4.3 (5.7)	.347
Readmissions, n (%)	1946 (12.9%)	243 (10.8%)	1703 (13.2%)	.002
Discharged to home				
LOS, mean (SD)	4.2 (5.0)	3.9 (5.0)	4.3 (5.0)	<.001
Readmissions	8199 (13.6%)	764 (10.8%)	7435 (13.7%)	.001
Discharged to SNF/rehabilitation				
LOS, mean (SD)	10.2 (12.4)	12.1 (16.5)	10.1 (12.2)	.009
Readmissions	2011 (15.7%)	77 (14.8%)	1934 (15.7%)	.619

DRG, diagnosis-related group; LOS, length of stay; SNF, skilled nursing facility.

as with healthy mothers being discharged from maternity services or patients being discharged from the psychiatry service.

Early discharges occurred in 11.2% of the medical population and 9.2% of the patients with a surgical discharge diagnosis. Presumably there is a projected LOS for patients after certain surgical procedures,

TABLE 3. Multivariate Analysis for Elevated LOS

	LOS > median, OR (95% CI)		
	Medical DRG	Surgical DRG	All patients
Discharge before noon	1.26 (1.18-1.35)	0.78 (0.71-0.86)	1.05 (0.99-1.11)
Weekday	1.42 (1.35-1.50)	1.36 (1.27-1.45)	1.41 (1.35-1.47)
SNF/rehabilitation	3.60 (3.37-3.85)	5.15 (4.71-5.63)	4.24 (4.03-4.47)
Medicaid	1.13 (1.07-1.20)	1.09 (1.01-1.18)	1.11 (1.06-1.16)
Medicare	1.09 (1.03-1.16)	1.07 (0.90-1.15)	1.09 (1.04-1.14)
CMI	5.19 (4.91-5.48)	1.89 (1.84-1.93)	2.23 (2.18-2.29)

CMI, case mix index; DRG, diagnosis-related group; LOS, length of stay; OR, odds ratio; SNF, skilled nursing facility.

TABLE 4. Multivariate Analysis for Readmissions

	Readmission, OR (95% CI)		
	Medical DRG	Surgical DRG	All patients
Discharge before noon	0.94 (0.86-1.03)	0.81 (0.69-0.95)	0.92 (0.84-1.01)
Weekday	0.95 (0.89-1.01)	1.12 (1.01-1.23)	1.01 (0.95-1.06)
Medicaid	1.14 (1.06-1.23)	1.31 (1.17-1.47)	1.19 (1.12-1.27)
Medicare	1.18 (1.10-1.27)	1.25 (1.13-1.39)	1.22 (1.15-1.29)
CMI	1.55 (1.49-1.61)	1.06 (1.05-1.08)	1.10 (1.09-1.12)

CMI, case mix index; DRG, diagnosis-related group; OR, odds ratio.

such as for hip fractures, which may allow for anticipated discharges to occur early in the day, whereas less certainty exists in medically complex cases. There may also be differential ancillary support for surgical teams, with advanced practice providers helping with discharges while surgeons are in the operating rooms.

Patients were much more frequently discharged before noon on weekends (15.9%) compared with weekdays (9.1%). As is the case with many other systems, ours has less staffing on the weekends but discharges may be anticipated on Friday. Alternatively, there may be more active patient care issues during the week but fewer procedures, testing, and surgeries performed on the weekend, which may make discharges easier and may account for the discrepancy. However, the results are somewhat counterintuitive given fewer resources available on the weekend.

Insurance status helped predict time of discharge. Patients with Medicare were discharged before noon proportionally less frequently (8.3% of all Medicare patients) compared with those with Medicaid (13.3%), private insurance (10.7%), or other (12.4%). The database-level information does not provide rationale for why this is the case, but future studies could explore whether this phenomenon is consistent across other health systems and demographics.

Patients discharged to SNF/rehabilitation left the hospital later in the day, presumably because of late acceptances or delays in transportation. Conversely, those patients who were discharged to home had fewer barriers to early discharge and were able to transition out of the hospital with fewer delays. Although this

makes intuitive sense, it helps illustrate where processes can be optimized in a health system. This study does not provide a deeper dive to identify why the delays in SNF/rehabilitation transfers occur but, rather, captures the signal that these processes can contribute to significant delays in throughput.

Because this was a retrospective study, we can postulate explanations for the results and differences in medical and surgical populations. In another recent retrospective analysis of pediatric patients (between 2014 and 2017), there were findings of lower LOS in medical but not surgical patients who were discharged before noon, opposite our findings.¹⁸ In this case, other factors in the pediatric population—namely, invested parents and primary disposition to home and not to facilities—may play important roles. Other studies have prospectively used Plan-Do-Study-Act methodology to address early discharges, including identifying accountability issues, team incentives, and identification of patients who could be discharged early.²⁰ Another group demonstrated that implementing a process improvement throughput project aimed at improving the discharge process was associated with a decrease in the time it took to discharge a patient (the primary outcome). Hospital LOS, a secondary outcome, decreased throughout the hospital after the study intervention, but LOS was not compared between patients who were discharged before noon vs after noon.²⁴

One retrospective analysis from a single academic center looking at adult patients discharged between July 2012 and April 2015 showed a higher LOS in patients discharged before noon than after noon, congruent with our results.¹⁷ The patient population in that study differed from ours in that it consisted largely of surgical patients and included patients in observation status. Patients with extremes of LOS (< 24 hours or > 20 days) were also excluded in that study. In addition, the authors reported that their institution emphasized DBN as a metric in 2014. In our opinion and despite the authors' laudable efforts (ie, use of interaction term), the push for that metric might have skewed the results by rewarding earlier discharges as opposed to late discharges the day before. Furthermore, since that publication, new regulations from CMS, such as the Medicare 2-midnight rule enacted in 2013, might have affected the inpatient classification of some patients. In a recent study of pediatric patients (between 2014 and 2016), there were findings of results with lower LOS in patients discharged before noon.²⁵

Readmission rates were significant in patients with a surgical DRG (OR, 0.81) and not in those with a medical DRG (Table 4). Surgical patients discharged before noon were also found to generally have a lower LOS. Taken together, the data suggest that this population of patients with primarily surgical DRGs was a healthier, less complicated group than those with medical DRGs. In general, those accepted for surgery have been risk stratified, optimized, and, if they have a surgical DRG, are not in the hospital with multiple active comorbidities. Although our data set did not allow differentiation of these more granular details, further studies should elucidate the interaction between readmissions in the medical and surgical populations.

Similar findings with differences in pre- and postnoon discharges were identified in a study by Wertheimer et al.¹⁴ We could not eliminate the possibility of confounding as an explanation for these findings, but dedicated studies may help shed light on these differences.

Limitations

We were unable to discern fine differences at the level of the individual patient. Population-level data are useful for assessing overall trends spanning a period of time. However, details are lost when this broader approach is adopted. In the absence of individual chart audits, details regarding the reason behind delays are absent. For example, database-level data do not provide information as to whether a patient was medically stable for discharge the evening before a morning discharge, and it is possible that some patients could have been unnecessarily held overnight. Diagnosis-specific trends in discharge are also not captured here, as diagnoses were collapsed into broad categories such as medical and surgical. Similarly, planned admissions or direct admissions could not be differentiated from emergency, unanticipated admissions. We also did not separately analyze the effect of discharge time on different lengths of hospital stay; for example, a DBN in a patient who has stayed for 20 days may look quite different from that in a patient who has stayed for 3 days. Future studies may seek to identify the particular factors associated with delays, including different staffing models, utilization of ancillary and support services, institution-specific characteristics, and relationships with SNFs, rehabilitation centers, and home health care agencies. Additional considerations include analysis of specific diagnoses and specific patient characteristics to better understand the needs of unique patient populations.

CONCLUSIONS

Hospital throughput improves patient experience and management. Early discharges must be balanced with ensuring safe transitions of care. In this single-center study at a tertiary academic center, we found that, among adult hospitalized patients with medical diagnoses, DBN was associated with higher LOS and not associated with readmission risk. Among patients with surgical diagnoses, DBN was associated with a lower LOS and a lower risk of readmission. Additional factors correlated with early discharges included being younger and less sick, being discharged on a weekend, and being on a primary service other than medical or surgical. Patients with later discharges were more likely to be sent to a rehabilitation center or SNF and more frequently discharged during a weekday. Identification of these factors may help health systems transition patients safely and efficiently out of the hospital. ■

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