Journal of HOSPITAL MEDICINE www.journalofhospitalmedicine.com

ORIGINAL RESEARCH

The Association Between Night or Weekend Admission and Hospitalization-Relevant Patient Outcomes

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Disclosure: Nothing to report.

Introduction: Nights and weekends represent a potentially high-risk time for hospitalized patients. Data regarding night or weekend admission and its impact on outcomes is limited. We studied the association between night or weekend admission and outcomes.

Methods: We reviewed 857 admissions to the general medicine services from the emergency department (ED) at our tertiary care hospital for demographic information, time and day of admission, and hospitalization-relevant outcomes (length of stay [LOS], hospital charges, intensive care unit [ICU] transfer during hospitalization, repeat ED visit within 30 days, readmission within 30 days, and poor outcome [ICU transfer, cardiac arrest, or death] within the first 24 hours of admission). Outcomes were compared between groups using univariate and multivariate modeling.

Results: Complete data for analysis were available for 824 patients. A total of 58% of patients were admitted at night and 22% were admitted during the weekend. Patients admitted at night as compared to those admitted during the day had a similar LOS (4.1 vs. 4.3, $P = 0.38$), hospital charges (25,200 vs. 27,500, $P = 0.17$), ICU transfer during hospitalization (3% vs. 6%, $P = 0.06$), 30 day repeat ED visit (22% vs. 20%, $P = 0.42$), 30 day readmission (20% vs. 17%, $P = 0.23$), and poor outcomes within 24 hours of admission (1% vs. 2%, $P = 0.15$). Patients admitted during the weekend as compared to those admitted during the week had lower hospital charges and lower likelihood of an ICU transfer but were otherwise similar.

Conclusion: Night or weekend admission was not associated with worse hospitalization-relevant outcomes at our tertiary care hospital. ***Journal of Hospital Medicine*** **2011;6:10–14.** © *2010 Society of Hospital Medicine.*

KEYWORDS: communication, continuity of care transition and discharge planning, education, outcomes measurement, patient safety, resident.

The hospitalist movement and increasingly stringent resident work hour restrictions have led to the utilization of shift work in many hospitals.[1] Use of nocturnist and night float systems, while often necessary, results in increased patient hand-offs. Research suggests that hand-offs in the inpatient setting can adversely affect patient outcomes as lack of continuity may increase the possibility of medical error.[2,3] In 2001, Bell et al.[4] found that mortality was higher among patients admitted on weekends as compared to weekdays. Uneven staffing, lack of supervision, and fragmented care were cited as potential contributing factors.[4] Similarly, Peberdy et al.[5] in 2008 revealed that patients were less likely to survive a cardiac arrest if it occurred at night or on weekends, again attributed in part to fragmented patient care and understaffing.

The results of these studies raise concerns as to whether increased reliance on shift work and resulting handoffs compromises patient care.[6,7] The aim of this study was to evaluate the potential association between night admission and hospitalization-relevant outcomes (length of stay [LOS], hospital charges, intensive care unit [ICU] transfer during hospitalization, repeat emergency department [ED] visit within 30 days of discharge, readmission within 30 days of discharge, and poor outcome [transfer to the ICU, cardiac arrest, or death] within the first 24 hours of admission) at an institution that exclusively uses nocturnists (night-shift based hospitalists) and a resident night float system for patients admitted at night to the general medicine service. A secondary aim was to determine the potential association between weekend admission and hospitalization-relevant outcomes.

Methods

Study Sample and Selection

We conducted a retrospective medical record review at a large urban academic hospital. Using an administrative hospital data set, we assembled a list of approximately 9000 admissions to the general medicine service from the ED between January 2008 and October 2008. We sampled consecutive admissions from 3 distinct periods beginning in January, April, and July to capture outcomes at various points in the academic year. We attempted to review approximately 10% of all charts equally distributed among the 3 sampling periods (ie, 900 charts total with one-third from each period) based on time available to the reviewers. We excluded patients not admitted to the general medicine service and patients without complete demographic or outcome information. We also excluded patients not admitted

2010 Society of Hospital Medicine DOI 10.1002/jhm.833
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from the ED given that the vast majority of admissions to our hospital during the night (96%) or weekend (93%) are from the ED. Patients admitted to the general medicine service are cared for either by a hospitalist or by a teaching team comprised of 1 attending (about 40% of whom are hospitalists), 1 resident, 1 to 2 interns, and 1 to 3 medical students. From 7 am to 6:59 pm patients are admitted to the care of 1 of the primary daytime admitting teams. From 7 pm to 6:59 am patients are admitted by nocturnists (hospitalist service) or night float residents (teaching service). These patients are handed off to day teams at 7 am. Hospitalist teams change service on a weekly to biweekly basis and resident teams switch on a monthly basis; there is no difference in physician staffing between the weekend and weekdays. The Northwestern University Institutional Review Board approved this study.

Data Acquisition and Medical Records Reviews

We obtained demographic data including gender, age, race and ethnicity, patient insurance, admission day (weekday vs. weekend), admission time (defined as the time that a patient receives a hospital bed, which at our institution is also the time that admitting teams receive report and assume care for the patient), and the International Classification of Disease codes required to determine the Major Diagnostic Category (MDC) and calculate the Charlson Comorbidity Index[8,9] as part of an administrative data set. We divided the admission time into night admission (defined as 7 pm to 6:59 am) and day admission (defined as 7:00 am to 6:59 pm). We created a chart abstraction tool to allow manual recording of the additional fields of admitting team (hospitalist vs. resident), 30 day repeat ED visit, 30 day readmission, and poor outcomes within the first 24 hours of admission, directly from the electronic record.

Study Outcomes

We evaluated each admission for the following 6 primary outcomes which were specified a priori: LOS (defined as discharge date and time minus admission date and time), hospital charges (defined as charges billed as recorded in the administrative data set), ICU transfer during hospitalization (defined as $\geq$1 ICU day in the administrative data set), 30 day repeat ED visit (defined as a visit to our ED within 30 days of discharge as assessed by chart abstraction), 30 day readmission (defined as any planned or unplanned admission to any inpatient service at our institution within 30 days of discharge as assessed by chart abstraction), and poor outcome within 24 hours of admission (defined as transfer to the ICU, cardiac arrest, or death as assessed by chart abstraction). Each of these outcomes has been used in prior work to assess the quality of inpatient care.[10,11]

Statistical Analysis

Interrater reliability between the 3 physician reviewers was assessed for 20 randomly selected admissions across the 4 separate review measures using interclass correlation coefficients. Comparisons between night admissions and day admissions, and between weekend and weekday admissions, for the continuous primary outcomes (LOS, hospital charges) were assessed using 2-tailed *t*-tests as well as Wilcoxon rank sum test. In the multivariable modeling, these outcomes were assessed by linear regression controlling for age, gender, race and ethnicity, Medicaid or self-pay insurance, admission to the hospitalist or teaching service, most common MDC categories, and Charlson Comorbidity Index. Because both outcomes were right-skewed, we separately assessed each after log-transformation controlling for the same variables.

All comparisons of the dichotomous primary outcomes (ICU transfer during hospitalization, 30 day repeat ED visit, 30 day readmission, and poor outcome within the first 24 hours after admission) were assessed at the univariate level by chi-squared test, and in the multivariable models using logistic regression, controlling for the same variables as the linear models above. All adjustments were specified a priori. All data analyses were conducted using Stata (College Station, TX; Version 11).

Results

We reviewed 857 records. After excluding 33 records lacking administrative data regarding gender, race and ethnicity, and other demographic variables, there were 824 medical records available for analysis. We reviewed a similar number of records from each time period: 274 from January 2008, 265 from April 2008, and 285 from July 2008. A total of 345 (42%) patients were admitted during the day, and 479 (58%) at night; 641 (78%) were admitted on weekdays, and 183 (22%) on weekends. The 33 excluded charts were similar to the included charts for both time of admission and outcomes. Results for parametric testing and nonparametric testing, as well as for log-transformation and non-log-transformation of the continuous outcomes were similar in both magnitude and statistical significance, so we present the parametric and nonlog-transformed results below for ease of interpretation.

Interrater reliability among the 3 reviewers was very high. There were no disagreements among the 20 multiple reviews for either poor outcomes within 24 hours of admission or admitting service; the interclass correlation coefficients for 30 day repeat ED visit and 30 day readmission were 0.97 and 0.87, respectively.

Patients admitted at night or on the weekend were similar to patients admitted during the day and week across age, gender, insurance class, MDC, and Charlson Comorbidity Index (Table 1). For unadjusted outcomes, patients admitted at night has a similar LOS, hospital charges, 30 day repeat ED visits, 30 day readmissions, and poor outcome within 24 hours of admission as those patients admitted during the day. They had a potentially lower chance of any ICU transfer during hospitalization though this did not reach statistical significance at $P < 0.05$ (night admission 6%, day admission 3%, $P = 0.06$) (Table 2).

Patients admitted to the hospital during the weekend were similar to patients admitted during the week for unadjusted LOS, 30 day repeat ED visit or readmission rate, and poor outcomes within 24 hours of admission as those admitted during the week; however, they had lower hospital

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TABLE 1. Baseline Characteristics of Patients

Characteristics	Time of Day: Day Admission (n = 345)	Time of Day: Night Admission (n = 479)	Day of the Week: Weekday Admission (n = 641)	Day of the Week: Weekend Admission (n = 183)
Age (years)	60.8	59.7	60.6	58.7
Gender (% male)	47	43	45	46
Race/Ethnicity (%)				
White, Asian, other	61	54	57	55
Black	34	38	37	34
Hispanic	5	8	6	10
Medicaid or self pay (%)	9	10	10	11
Major diagnostic category (%)				
Respiratory disease	14	13	14	13
Circulatory disease	28	23	26	24
Digestive disease	12	12	12	12
Other	45	52	48	51
Charlson Comorbidity Index	3.71	3.60	3.66	3.60

NOTE: All *P* values > 0.05.
Abbreviation: ED, emergency department.

TABLE 2. Outcomes, Unadjusted

Outcomes	Time of Day: Day Admission (n = 345)	Time of Day: Night Admission (n = 479)	Day of the Week: Weekday Admission (n = 641)	Day of the Week: Weekend Admission (n = 183)
Length of stay	4.3	4.1	4.3	3.8
Hospital charges	$27,500	$25,200	**$27,200***	**$22,700***
ICU transfer during hospitalization (%)	6†	3†	**5***	**1***
Repeat ED visit at 30 days (%)	20	22	22	21
Readmission at 30 days (%)	17	20	20	17
Poor outcome at 24 hours (ICU transfer, cardiac arrest, or death)(%)	2	1	2	1

Abbreviations: ED, emergency department; ICU, intensive care unit.
† $P < 0.05$.
* $P = 0.06$.

TABLE 3. Linear Regressions for Continuous Outcomes (With Coefficients)

Predictors	Length of Stay (days), Coefficient (95% CI)	Hospital Charges (dollars), Coefficient (95% CI)
Night admission	−0.23 (−0.77 to 0.32)	−2100 (−5400 to 1100)
Weekend admission	−0.42 (−1.07 to 0.23)	**−4400 (−8300 to −600)***
Age	0.01 (−0.01 to 0.03)	0 (−100 to 100)
Male gender	−0.15 (−0.70 to 0.39)	−400 (−3700 to 2800)
Race, Black	0.18 (−0.41 to 0.78)	−200 (−3700 to 3400)
Ethnicity, Hispanic	−0.62 (−1.73 to 0.49)	−2300 (−8900 to 4300)
Medicaid or self-pay insurance	**1.87 (0.93 to 2.82)***	**8900 (3300 to 14600)***
Hospitalist service	0.26 (−0.29 to 0.81)	−600 (−3900 to 2700)
MDC: respiratory	−0.36 (−1.18 to 0.46)	700 (−4200 to 5600)
MDC: circulatory	**−1.36 (−2.04 to −0.68)***	−600 (−4600 to 3400)
MDC: digestive	**−1.22 (−2.08 to −0.35)***	**−6800 (−12000 to −1700)***
Charlson Comorbidity Index	**0.35 (0.22 to 0.49)***	**2200 (1400 to 3000)***

Abbreviations: CI, confidence intervals; ICU, intensive care unit; MDC, major diagnostic category: comparison to "other".
* $P < 0.05$.

TABLE 4. Logistic Regressions for Dichotomous Outcomes (With Odds Ratios)

Predictors	ICU Transfer during Hospitalization, Odds Ratio (95% CI)	Repeat ED Visit at 30 days, Odds Ratio (95% CI)	Readmission at 30 days, Odds Ratio (95% CI)
Night admission	0.53 (0.26 to 1.11)	1.13 (0.80 to 1.60)	1.23 (0.86 to 1.78)
Weekend admission	**0.20 (0.05 to 0.88)***	0.95 (0.63 to 1.44)	0.80 (0.51 to 1.25)
Age	1.00 (0.98 to 1.02)	0.99 (0.98 to 1.002)	1.00 (0.99 to 1.01)
Male gender	0.98 (0.47 to 2.02)	1.09 (0.78 to 1.54)	0.91 (0.64 to 1.31)
Race, Black	0.75 (0.33 to 1.70)	**1.48 (1.02 to 2.14)***	1.12 (0.76 to 1.65)
Ethnicity, Hispanic	0.76 (0.16 to 3.73)	1.09 (0.55 to 2.17)	1.11 (0.55 to 2.22)
Medicaid or self-pay insurance	0.75 (0.16 to 3.49)	1.61 (0.95 to 2.72)	**2.14 (1.24 to 3.67)***
Hospitalist service	0.68 (0.33 to 1.44)	1.15 (0.81 to 1.63)	0.99 (0.69 to 1.43)
MDC: respiratory	1.18 (0.41 to 3.38)	1.02 (0.61 to 1.69)	1.16 (0.69 to 1.95)
MDC: circulatory	1.22 (0.52 to 2.87)	0.79 (0.51 to 1.22)	0.80 (0.51 to 1.27)
MDC: digestive	0.51 (0.11 to 2.32)	0.83 (0.47 to 1.46)	1.08 (0.62 to 1.91)
Charlson Comobrbidity Index	**1.25 (1.09 to 1.45)***	**1.09 (1.01 to 1.19)***	**1.11 (1.02 to 1.21)***

Abbreviations: CI, confidence intervals; ICU, intensive care unit; MDC, major diagnostic category: comparison to "other."
* $P < 0.05$.

charges (weekend admission $22,700, weekday admission $27,200; $P = 0.02$), and a lower chance of ICU transfer during hospitalization (weekend admission 1%, weekday admission 5%; $P = 0.02$) (Table 2).

In the multivariable linear and logistic regression models (Tables 3 and 4), we assessed the independent association between night admission or weekend admission and each hospitalization-relevant outcome except for poor outcome within 24 hours of admission (poor outcome within 24 hours of admission was not modeled to avoid the risk of overfitting because there were only 13 total events). After adjustment for age, gender, race and ethnicity, admitting service (hospitalist or teaching), Medicaid or self-pay insurance, MDC, and Charlson Comorbidity Index, there was no statistically significant association between night admission and worse outcomes for LOS, hospital charges, 30 day repeat ED visit, or 30 day readmission. Night admission was associated with a decreased chance of ICU transfer during hospitalization, but the difference was not statistically significant (odds ratio, 0.54; 95% confidence interval [CI], 0.26-

2010 Society of Hospital Medicine DOI 10.1002/jhm.833
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1.11, $P = 0.09$). Weekend admission was not associated with worse outcomes for LOS or 30 day repeat ED visit or readmission; however, weekend admission was associated with a decrease in overall charges (−$4400; 95% CI, −$8300 to −$600) and a decreased chance of ICU transfer during hospitalization (odds ratio, 0.20; 95% CI, 0.05–0.88).

Our multivariate models explained very little of the variance in patient outcomes. For LOS and hospital charges, adjusted R^2 values were 0.06 and 0.05, respectively. For ICU transfer during hospitalization, 30 day repeat ED visit, and 30 day readmission, the areas under the receiver operator curves were 0.75, 0.51, and 0.61 respectively.

To assess the robustness of our conclusions regarding night admission, we redefined night to include only patients admitted between the hours of 8 pm and 5:59 am. This did not change our conclusions. We also tested for interaction between night admission and weekend admission for all outcomes to assess whether night admissions on the weekend were in fact at increased risk of worse outcomes; we found no evidence of interaction ($P > 0.3$ for the interaction terms in each model).

Discussion

Among patients admitted to the medicine services at our academic medical center, night or weekend admission was not associated with worse hospitalization-relevant outcomes. In some cases, night or weekend admission was associated with better outcomes, particularly in terms of ICU transfer during hospitalization and hospital charges. Prior research indicates worse outcomes during "off-hours,"[5] but we did not replicate this finding in our study.

The finding that admission at night was not associated with worse outcomes, particularly proximal outcomes such as LOS or ICU transfer during hospitalization, was surprising, though reassuring in view of the fact that more than half of our patients are admitted at night. We believe a few factors may be responsible. First, our general medicine service is staffed during the night (7 pm to 7 am) by in-house nocturnists and night float residents. Second, our staffing ratio, while lower at night than during the day, remains the same on weekends and may be higher than in other settings. In continuously well-staffed settings such as the ED[12] and ICU,[13] night and weekend admissions are only inconsistently associated with worse outcomes, which may be the same phenomena we observed in the current study. Third, the hospital used as the site of this study has received Nursing Magnet® recognition and numerous quality awards such as the National Research Corporation's Consumer Choice Award and recognition as a Distinguished Hospital for Clinical Excellence by HealthGrades. Fourth, our integrated electronic medical record, computerized physician order entry system, and automatically generated sign out serve as complements to the morning hand off. Fifth, hospitalists and teaching teams rotate on a weekly, biweekly, or every 4 week basis, which may protect against discontinuity associated with the weekend. We believe that all of these factors may facilitate alert, comprehensive care during the night and weekend as well as safe and efficient transfer of patients from the night to the day providers.

We were also surprised by the association between weekend admission and lower charges and a lower chance of ICU transfer during hospitalization. We believe many of the same factors noted above may have played a role in these findings. In terms of hospital charges, it is possible that some workups were completed outside of the hospital rather than during the hospitalization, and that some tests were not ordered at all due to unavailability on weekends. The decreased chance of ICU transfer is unexplained. We hypothesize that there may have been a more conservative admission strategy within the ED, such that patients with high baseline severity were admitted directly to the ICU on the weekend rather than being admitted first to the general medicine floor. This hypothesis requires further study.

Our study had important limitations. It was a retrospective study from a single academic hospital. The sample size lacked sufficient power to detect differences in the low frequency of certain outcomes such as poor outcomes within 24 hours of admission (2% vs. 1%), and also for more frequent outcomes such as 30 day readmission; it is possible that with a larger sample there would have been statistically significant differences. Further, we recognize that the Charlson Comorbidity Index, which was developed to predict 1-year mortality for medicine service patients, does not adjust for severity of illness at presentation, particularly for outcomes such as readmission. If patients admitted at night and during the weekend were less acutely ill despite having similar comorbidities and MDCs at admission, true associations between time of admission and worse outcomes could have been masked. Furthermore, the multivariable modeling explained very little of the variance in patient outcomes such that significant unmeasured confounding may still be present, and consequently our results cannot be interpreted in a causal way. Data was collected from electronic records, so it is possible that some adverse events were not recorded. However, it seems unlikely that major events such as death and transfer to an ICU would have been missed.

Several aspects of the study strengthen our confidence in the findings, including a large sample size, relevance of the outcomes, the adjustment for confounders, and an assessment for robustness of the conclusions based on restricting the definition of night and also testing for interaction between night and weekend admission. Our patient demographics and insurance mix resemble that of other academic hospitals,[10] and perhaps our results may be generalizable to these settings, if not to non-urban or community hospitals. Furthermore, the Charlson Comorbidity Index was associated with all 5 of the modeled outcomes we chose for our study, reaffirming their utility in assessing the quality of hospital care. Future directions for investigation may include examining the association of night admission with hospitalization-relevant outcomes in nonacademic, nonurban settings, and examining whether the lack of association

2010 Society of Hospital Medicine DOI 10.1002/jhm.833
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between night and weekend admission and worse outcomes persists with adjustment for initial severity of illness.

In summary, at a large, well-staffed urban academic hospital, day or time of admission were not associated with worse hospitalization-relevant outcomes. The use of nocturnists and night float teams for night admissions and continuity across weekends appears to be a safe approach to handling the increased volume of patients admitted at night, and a viable alternative to overnight call in the era of work hour restrictions.

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 DOI 10.1002/jhm.833
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