Effect of Short Call Admission on Length of Stay and Quality of Care for Acute Decompensated Heart Failure

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Background—In response to residency work hour restrictions, programs restructured call schedules, increasing the use of short call (daytime admitting teams). Few data exist on the effect of short call on quality of patient care. Our objective was to examine the effect of short call admission on length of stay and quality of care for patients with acute decompensated heart failure.

Methods and Results—We conducted a retrospective cohort study of 218 patients admitted with acute decompensated heart failure to the Nashville VA Medical Center between July 1, 2003, and June 30, 2005. The primary exposure was short call, and the primary outcome was length of stay. The secondary outcomes—diuretic dosing, weight monitoring, and hospital complications—were determined through a combination of administrative data and chart review. Patients admitted to short call had a longer median length of stay than patients admitted to long call (5.2 days [25% to 75%, 3.2 to 8 days] versus 3.9 days [interquartile range, 2.7 to 6.5 days]; P=0.0004). After adjustment for covariates, short call had a 44% increase in length of stay (95% CI, 15 to 80) compared with long call. Short call patients received fewer diuretic doses in the first 24 hours of hospitalization (1.80 versus 2.12; P=0.014) and had a longer median time to the second dose of loop diuretics compared with long call patients (17.9 hours versus 16.2 hours; P=0.044).

Conclusions—Admission to short call is predictive of increased length of stay, a decreased number of diuretic doses, and delays in the timing of diuretics among patients with acute decompensated heart failure. Additional studies are needed to clarify the impact of short call admission on inpatient quality of care. (Circulation. 2008;117:2637-2644.)

Key Words: education, graduate ■ heart failure ■ healthcare quality, access and evaluation

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or an early handoff on the quality of care for patients. In a randomized trial, Landrigan and colleagues reported that interns made fewer serious medical errors when working shorter shifts. However, continuity of patient care was maximized by maintaining 24-hour resident shifts. Other observational studies of resident work hour restrictions are inconsistent, yielding positive, neutral, and negative effects on patient care.

Our aim was to examine the effect of short call on the processes and outcomes of patient care for patients admitted with acute decompensated heart failure (ADHF). Observational studies of ADHF have shown an association between delay in treatment initiation and increasing length of stay (LOS). Recommendations for early treatment of ADHF have been published and include rapid assessment and treatment initiation. Patients should subsequently be reassessed and loop diuretics redosed if appropriate response is not achieved within 8 hours of presentation. The timely assessment for response to therapy is an important component of ADHF treatment and may be affected by short call admission. We hypothesize that ADHF patients are especially susceptible to delays in processes of care and subsequently a longer LOS if admitted to short call.

**Methods**

**Study Design and Setting**

We conducted a retrospective cohort study of ADHF patients admitted to the Veterans Affairs Tennessee Valley Healthcare System Nashville Campus (VA TVHS-Nashville) during 2 academic years (July 1, 2003, through June 30, 2005). TVHS-Nashville is an academic tertiary care VA Medical Center situated in middle Tennessee with 118 acute care beds and admissions per year. The medicine service is staffed by 16 to 18 residents each month in a team structure. The VA TVHS-Nashville campus, similar to most VA facilities, uses a computerized patient record system that allows real-time information processing as both an electronic medical record and computerized physician order entry system. During the study time period, no ADHF clinical pathway was used as part of patient care. The Vanderbilt University and VA Institutional Review Boards and Research and Development Committee approved the study.

**Data Sources**

The Mid-South Data Warehouse is a relational database of local and network-wide data updated monthly from the Veterans’ Health Information System and Technology Architecture clinical information systems. It contains patient-specific information, including billing, prescriptions, vitals signs, diagnoses, and laboratory data. During the study period, diagnoses associated with healthcare visits were coded according to the *International Classification of Diseases*, ninth revision, clinical modification (ICD 9-CM).

**Patient Population**

We identified 522 patients who had an ADHF admission to the VA TVHS-Nashville campus between July 1, 2003, and June 30, 2005. Our search strategy included any patient admitted with a primary discharge diagnosis for heart failure (ICD 9-CM code 428 or diagnosis-related group code 127). ADHF at presentation was confirmed through chart review using the Framingham criteria (sensitivity, 100%; specificity, 78%; see Table 1). Only the patients who met the Framingham criteria were included in the study population. Furthermore, patients were excluded if not admitted to medicine, transferred to an intensive care unit (ICU) within 4 hours of admission, admitted on Saturday or Sunday (no short call on weekends), or admitted by night float or during the winter holiday.

**Exposure Classification: Team Structure**

Each patient was admitted to a team, and that team had primary responsibility for the patient’s care throughout the hospitalization until discharge. Depending on the time of admission, the patient’s admission was classified as long call or short call. Long call teams remain in the hospital overnight, resolve any problems with patients that may occur (cross cover), and admit new patients after 4 AM. During the study period, the duty hour policy for maximum shift duration was 24 hours plus an additional 6 hours. Short call teams admit during the day, leave the hospital after completing their work, and transfer patient care responsibilities to the long call teams for overnight coverage.

The call structure and schedule are detailed in Figure 1. During the first academic year (July 1, 2003, to June 30, 2004), each month the service was staffed by 8 teams made up of 1 resident and 1 intern. Two long call teams remained overnight every fourth day. Two days later, they became a short call team. Each long call team admitted up to 8 patients, and each short call team admitted up to 2 patients. During the second academic year (July 1, 2004, to June 30, 2005), each month the service was staffed by 6 teams of 1 resident and 2 interns. Each team admitted patients every other day on an alternating schedule. On day 1, they would admit as overnight call; 2 days later, they were on an intermediate call schedule; and 2 days later, they would admit on a short call schedule. The long call team admitted up to 10 patients per call (every sixth night). Each short and intermediate call team admitted up to 4 patients. Short and intermediate call teams admit Monday through Friday. A total of 204 residents rotated through the general medicine service during the 2-year study period. Once all data had been extracted from the medical records, we cross-referenced the admission note author with the call schedule to determine the admitting resident call status.

**Outcomes**

The primary outcome for analysis was acute care LOS defined as the interval from admission time to discharge time or transfer to a nonacute care ward. This was measured as number of minutes from admission to discharge and converted to days. For example, a patient who was admitted at 6 AM on January 1 and discharged at noon on January 3 would have an acute LOS of 2.25 days.

Secondary outcomes include process of care measures for the treatment of ADHF. We assessed the number of loop diuretic doses...

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**Table 1. Framingham Criteria: Diagnosis of ADHF Requires the Simultaneous Presence of at Least 2 Major Criteria or 1 Major Criterion in Conjunction With 2 Minor Criteria**

<table>
<thead>
<tr>
<th>Major Criteria</th>
<th>Minor Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paroxysmal nocturnal dyspnea</td>
<td>Night cough</td>
</tr>
<tr>
<td>Orthopnea</td>
<td>Dyspnea with exertion</td>
</tr>
<tr>
<td>HF treatment-related 10-lb weight loss in 5 d</td>
<td>Non-HF treatment-related 10-lb weight loss in 5 d</td>
</tr>
<tr>
<td>Elevated jugular venous pressure (&gt;16 cm H2O at right atrium)</td>
<td>Hepatomegaly</td>
</tr>
<tr>
<td>S3 gallop</td>
<td>Bilateral ankle edema</td>
</tr>
<tr>
<td>Positive hepatojugular reflex</td>
<td>Pleural effusion</td>
</tr>
<tr>
<td>Rales or crackles</td>
<td>Tachycardia (heart rate &gt;120 bpm)</td>
</tr>
<tr>
<td>Cardiomegaly</td>
<td>Pulmonary edema</td>
</tr>
</tbody>
</table>

HF indicates heart failure.
given in the first 24 hours after admission and the time from admission to the administration of the second diuretic dose. We also assessed the documentation of admission weight (within 24 hours) and 48-hour weight change defined as the difference between the first and last weights obtained within 48 hours. Finally, we measured hospital complications. These were defined as worsening renal function (>0.3-mg/dL increase in serum creatinine from admission level), transfer to an ICU, or inpatient mortality.

**Data Collection and Measurements**
Patient demographics, date and time of admission and discharge, laboratory data, vital signs, medications, and ICD-9 codes were extracted from administrative data. The data warehouse began collecting inpatient medication data derived from the Bar Code Medication Administration system on October 1, 2003; therefore, patients admitted between July 1, 2003, and September 30, 2003, were missing inpatient medications. Inpatient and outpatient ICD-9 codes for the year before admission were used to calculate a Charlson-Deyo score\(^\text{33}\) at the time of admission.

Electronic records were manually reviewed by a study investigator (J.L.S.) and a research nurse to determine eligibility and extract information (admitting resident and presenting characteristics). Fifty randomly selected charts were reviewed for interrater reliability. We found \(\kappa\) coefficients between 0.64 and 1.00 (call team \(\kappa=0.98\), Framingham criteria \(\kappa=0.64\) to 1.00, smoking status \(\kappa=0.80\), and baseline left ventricular ejection fraction \(\kappa=0.86\)).

**Statistical Analysis**
Using descriptive statistics, proportions, means, SDs, and ranges, we examined demographics of the patients at presentation. Continuous variables were compared by the use of 2-tailed \(t\) tests or Wilcoxon rank-sum tests, with results presented as mean±SD or medians and ranges (quartiles 1 through 3). Categorical outcomes were compared through the use of \(\chi^2\) or Fisher’s exact test.

Because the primary outcome, acute LOS, was highly skewed, we used a log-gamma generalized linear model, which is often more robust when outcomes are skewed.\(^\text{34,35}\) We derived the final model by determining a priori covariates for inclusion based on clinical significance (potential confounders). The principal adjusted analysis was a multivariate linear regression of acute LOS by short or long call with adjustment for Charlson-Deyo comorbidity scores (Charlson-Deyo ≤1, 2 to 3, or ≥4), weekday of admission (Monday through Friday), academic year (2003 to 2004 or 2004 to 2005), age, nursing home residence, admission creatinine, and time of admission (number of hours since midnight).

We conducted 2 analyses on the primary outcome of interest: the principal analysis to determine the effect of call status on length of stay and an alternative analysis using propensity scores to adjust for potential confounders. Because our sample size was not sufficient to directly adjust for all baseline patient characteristics, we used a propensity score as a data reduction technique.\(^\text{36}\) Each patient’s available characteristics are summarized as a probability of being admitted to short call. This is estimated by a logistic regression of short/long call by all potential confounders, including all baseline patient characteristics (Table 2) and time, day, and year of admission. These probabilities, or propensity scores, are then used as a covariate in a log-gamma model of LOS by short/long call. To avoid assuming linearity, a third-degree polynomial of the propensity scores was used. Point estimates with 95% CIs and respective probability values are reported.

For the secondary outcome, the number of diuretic doses given in the first 24 hours and the time from admission to the second diuretic dose, we also conducted multivariate log-gamma models. These models adjusted for comorbidity scores; day, year, and time of admission; age; nursing home residence; and creatinine. All analyses were performed with STATA software version 8.2 (STATA Corp, College Station, Tex).

The authors had full access to and take responsibility for the integrity of the data. All authors have read and agree to the manuscript as written.

**Results**

**Patient Identification and Characteristics**
We identified 522 ADHF admissions between July 1, 2003, and June 30, 2005 (Figure 2). Two hundred eighteen patients (41.8%) met inclusion criteria. Of the 218 study patients, 152 (69.7%) were admitted by long call, and 66 (30.3%) were admitted by short call. Baseline patient characteristics are presented in Table 2. There were no statistically significant
Primary Outcome: LOS
Short call patients had a longer median LOS than long call patients (5.2 days [quartile 1 through 3, 3.2 to 8.0 days] versus 3.9 days [quartile 1 through 3, 2.7 to 6.5]; \(P=0.0004\)).
A regression of LOS by admission team estimated a 41% (95% CI, 13 to 76; \(P = 0.002\)) increase in LOS with short call compared with long call. After adjustment for Charlson-Deyo comorbidity scores, age, nursing home residence, admission creatinine, and day, time, and academic year of admission, we estimated a 44% (95% CI, 15 to 80; \(P = 0.001\)) increase in LOS with short call compared with long call (Table 3).

We also conducted a propensity score analysis on the outcome of LOS by short or long call to adjust for potential confounders. In this analysis, we estimated a 52% (95% CI, 16 to 99; \(P = 0.003\)) increase in LOS with short call compared with long call.

Secondary Outcomes: Process of Care

Inpatient medication administration data were available for 191 of the 218 (87.6%) patients (129 of 152 long call patients [84.9%] versus 62 of 66 short call patients [93.9%]). Short call patients received fewer diuretic doses in the first 24 hours of hospitalization than long call patients (mean number of diuretic doses, 1.80 ± 0.79 versus 2.12 ± 0.83; \(P = 0.014\); Table 3). In adjusted regression analysis, short call patients had a 16% decrease in the number of diuretic doses in the first 24 hours compared with long call patients (95% CI, -3 to -27.3; \(P = 0.015\)).

Of the 191 patients who had inpatient medication administration data available, 179 (93.7%) received at least 2 loop diuretic doses during their hospitalization (121 of 129 long call patients [93.8%] versus 58 of 62 short call patients [93.5%]). The median interval to the second dose was longer among patients admitted to short call than long call (17.9 hours [95% CI, 9.8 to 46.2] versus 16.2 hours [95% CI, 8.6 to 35.8]; \(P = 0.044\)). After covariate adjustment, short call patients had a 25% increase in the time to second diuretic dose (95% CI, 2.4 to 52.9; \(P = 0.029\)). We also performed the propensity score analysis for secondary outcomes. The estimated effect size of short call and its statistical significance were similar in the propensity score–adjusted model and the log-gamma models, which adjusted for the a priori selected covariates.

One hundred thirteen of the 152 long call patients (74.3%) and 43 of 66 short call patients (65.1%) had admission weight documented (\(P = 0.167\)). We examined the proportion of patients who had at least 2 weights documented within 48 hours of admission (73 of 152 long call [48.0%] and 26 of 66 short call [39.4%]; \(P = 0.24\)). There was no statistically significant difference in 48-hour weight change (Table 3).

Complication Rates

No differences were detected in complication rates between long and short call patients (Table 3). Worsening renal function developed in 28 of 152 long call (18.4%) and 15 of 66 short call patients (22.7%; \(P = 0.46\)). Eleven of the 152 long call (7.2%) and 5 of 66 short call (7.6%) patients required ICU transfer (\(P = 0.93\)). There was no difference in inpatient mortality between long call (1 of 152 [0.7%]) and short call (2 of 66 [3.0%]; \(P = 0.167\)).

Discussion

We demonstrated that patients admitted with ADHF by short call have a 1.3-day increase in median LOS compared with those admitted by long call (44% increase in LOS; 95% CI, 15 to 80). We also report that patients admitted by short call...
received fewer diuretic doses in the first 24 hours and have a longer interval to diuretic administration than long call patients. Although our study does not establish a mechanism between care processes and LOS, the significant differences in diuretic administration may be contributing to the observed differences in LOS. It also should be noted that despite the differences in the process of care measures between short and long call, the number of complications, including transfer to the ICU, was similar between patients admitted to short or long call.

The rationale for limiting residency work hours was to improve workplace safety by decreasing provider fatigue. Gottlieb and colleagues\textsuperscript{6} found decreased patient LOS, resource use, and medical errors after reorganization of their internal medicine call schedule and implementation of a night float team. Recognizing the potential adverse impact that resident discontinuity could have on patient care, Landrigan et al\textsuperscript{12} designed a randomized trial that examined the effect of reduced intern shift length in the ICU while maintaining patient continuity of care. This reduced shift length led to fewer serious medical errors, and the authors concluded that “elimination of extended work shifts in a system that minimizes cross-coverage can improve patients’ safety.”\textsuperscript{12} However, many of the strategies used to reduce work hours, especially in non-ICU settings, result in increased cross-coverage.

In contrast to the Landrigan et al\textsuperscript{12} randomized trial, we examined the effect of short call among ADHF patients in whom provider discontinuity can affect patient care. Our findings are consistent with previous work identifying discontinuity of care as a risk factor for increased LOS. Lofgren et al\textsuperscript{16} compared patients admitted by night float with those admitted by a primary team and found that night float admission led to increased laboratory testing and a trend toward longer LOS. Smith and colleagues\textsuperscript{18} reported that among acute myocardial infarction patients, end-of-the-month admission was associated with increased LOS. Petersen et al\textsuperscript{5} reported that preventable medical errors occurred more commonly during cross-cover than when patients were cared for by their primary team.

Our study differs from previous observational studies in that our focus was on the effect of short call on both the process of care and outcomes. Evaluating the processes of care can often help investigators understand why differences in care may occur. In our study, there were small but significant differences in the process measures. We are uncertain, however, if these differences in the processes of care are responsible for the increased LOS among short call patients. The Heart Failure Society of America treatment guidelines for ADHF include early diuresis, frequent reevaluation, and daily weight monitoring as important components

| Table 3. LOS, Processes of Care, and Complications for Patients Admitted With ADHF |
|---------------------------------|-----------------|-----------------|---|
| **Primary outcome** | | | |
| LOS, median (Q1–Q3), d | 3.9 (2.7 to 6.5) | 5.2 (3.2 to 8) | 0.0004 |
| Unadjusted model of LOS (95% CI), % increase | Reference | 41 (13 to 76) | 0.002 |
| Adjusted model of LOS, (95% CI), % increase* | Reference | 44 (15 to 80) | 0.002 |
| **Secondary outcomes: processes of care** | | | |
| Diuretic doses in 24 h, mean±SD† | 2.12±0.83 | 1.80±0.79 | 0.014 |
| Adjusted model (95% CI), % decrease in no. of doses* | Reference | −16 (−3 to −27.3) | 0.015 |
| Time to second diuretic dose, median (95% CI), h‡ | 16.2 (8.6 to 35.8) | 17.9 (9.8 to 46.2) | 0.044 |
| Adjusted model (95% CI), % increase in time to second dose* | Reference | 25 (2.4 to 52.9) | 0.029 |
| Admission weight documented, n (%) | 113/152 (74.3) | 43/66 (65.16) | 0.167 |
| ≥2 Weights documented in first 48 h, n (%) | 73/152 (48.0) | 26/66 (39.4) | 0.24 |
| 48-h Weight change, median (95% CI), kg§ | −2.73 (−12.36 to 2.72) | −3.17 (−11.5 to 0.45) | 0.88 |
| **Complications** | | | |
| Worsening renal function, n (%) | 28/152 (18.4) | 15/66 (22.7) | 0.46 |
| Odds of developing worsening renal function\textsuperscript{||} | Reference | 1.55 (0.71 to 3.38) | 0.27 |
| ICU transfer, n (%) | 11/152 (7.2) | 5/66 (7.6) | 0.93 |
| Death, n (%) | 1/152 (0.7) | 2/66 (3.0) | 0.167 |

*Log-gamma linear model was adjusted for comorbidity (Charlson-Deyo ≥1, 2 to 3, ≥4), age, nursing home status, admission creatinine, day, academic year, and time of day (hours since midnight).
†Long call, n=124; short call, n=61.
‡Long call, n=121; short call, n=58.
§Long call, n=73; short call, n=26.
\textsuperscript{||}Logistic regression analysis was adjusted for admission creatinine and academic year of admission.
of care. Our findings suggest that early provider discontinuity may affect these components of care. Even small delays in the initiation of care for ADHF patients can translate into large increases in LOS. The Acute Decompensated Heart Failure National Registry studied the quality of care among patients with ADHF. In 1 study, nesiritide was initiated within a median of 2.8 hours (emergency department group) versus 15.5 hours (inpatient group). This initial 12-hour difference translated into an increase in LOS of almost 2 days among those who had delays in care.

Our work does not in any way undermine the benefit that has occurred from reduced physician fatigue; however, it highlights the need to explore ways to mitigate negative consequences of work hour restrictions. Additional studies are required to determine whether the differences we observed in ADHF occur in the care of patients with other diseases in which delays in treatment can affect both care processes and patient outcomes. Examining and improving the process of care, in addition to patient outcomes, is an essential component of future studies.

Our study must be interpreted in light of certain limitations. The population was limited to ADHF patients admitted to a single VA hospital over a 2-year period. The study was retrospective in design with a moderate sample size in which the primary exposure, short call, was not randomized, and only 218 of 522 potential admissions for ADHF met eligibility criteria. All of these factors limit the generalizability of our study to other institutions using similar call structures. Because the medicine team organization and call schedule changed during our study, we included academic year of admission as a covariate, and it was not a significant predictor of patient outcomes. Most concerning, a key process measure (patient weight) was poorly documented. Only two thirds of patients had admission weights, and fewer than half had 2 weights documented within 48 hours. This study probably was underpowered to detect differences in this key secondary measure because of missing data. The magnitude of the increase in LOS was surprising given the modest observed changes in diuretic administration. We also note that 48-hour weight change was similar in the subset of both call groups with available data, suggesting that any difference in initial treatment may have resolved midway through a typical hospital stay. Unmeasured confounders may explain part of the increase in LOS between the patients admitted to long call and short call. Anecdotal experience at our institution is that the increase in LOS between the patients admitted to long call can proxy for severity of illness, admission source, and reason for stay beyond exacerbation of heart failure. Our regression models and our alternative propensity score analysis adjusted for the time of patient admission and a number of other covariates. Our results were consistent between the 2 analyses, with short call patients having a statistically significant longer LOS. However, there may yet be other unmeasured differences between short and long call that may explain this observed difference in effect.

Conclusions

Our study demonstrates that short call admission is predictive of fewer number of diuretic doses administered, greater delay in administration of diuretics, and an increase in LOS. These results suggest that delays in the process of care (diuretic administration) may affect patient outcomes (LOS). The work hour restrictions are meant to protect patient safety by preventing provider fatigue; however, the resulting loss in continuity from short call admission produces vulnerability to delays in treatment. Additional studies are needed to confirm these results and to further evaluate the impact of work hour restrictions. New care processes should be designed, evaluated, and implemented to take advantage of the improvements in safety afforded by work hour restrictions while compensating for their potential negative consequences on the quality of care.

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Disclosures

None.

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**CLINICAL PERSPECTIVE**

We studied the quality of care delivered for patients admitted to an academic-affiliated Veterans Affairs Medical Center for acute decompensated heart failure. We were concerned that patients who were admitted to a resident short call team might have delays in the processes of their care such as the time to second diuretic dose and subsequently a longer length of stay. Short call teams (primary team) admit during the daytime and transfer patient care to physicians for overnight coverage (long call). Care is then transferred back to the primary team in the morning. These transfers potentially result in delays in care. We studied 218 patients with acute decompensated heart failure admitted to either short call or long call between July 1, 2003, and June 30, 2005. Patients admitted to short call had a longer median length of stay than patients admitted to long call (5.2 versus 3.9 days; P=0.0004). After adjustment for patient characteristics and comorbidities, short call patients had a 44% increase in length of stay compared with long call patients. Short call patients received fewer diuretic doses in the first 24 hours of hospitalization (1.80 versus 2.12; P=0.01) and had a longer median time to the second dose of loop diuretics compared with long call patients (17.9 versus 16.2 hours; P=0.04). Additional studies are needed to clarify the impact of short call admission at academic medical centers on inpatient quality of care.
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