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ORIGINAL RESEARCH

Discharge Before Noon: Effect on Throughput and Sustainability

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BACKGROUND: Late afternoon hospital discharges are thought to contribute to admission bottlenecks. We previously described an intervention that resulted in a statistically significant increase in the discharge before noon (DBN) rate on 2 inpatient medicine units.

OBJECTIVE: To evaluate (1) the effect of an increased DBN rate on the admission arrival time and the number of admissions per hour and (2) the sustainability of our DBN initiative.

DESIGN: Pre-/postintervention retrospective analysis.

SETTING: Two acute-care inpatient medicine units in a tertiary care, urban, academic medical center.

PATIENTS: For the admission arrival time and admissions per hour analysis, all inpatients admitted to the medical units from June 1, 2011 to June 31, 2013. For the sustainability analysis, all patients discharged from July 1, 2013 to December 31, 2014.

INTERVENTION: A multidisciplinary intervention to increase the DBN rate.

MEASUREMENTS: Date and time of arrival to all inpatient sites, and discharge date and time of all patients from 2 inpatient medicine units.

RESULTS: Concurrent with our increase in DBN rate, we found a statistically significant change in the median arrival time of emergency department (ED) admissions and transfers from 5 PM to 4 PM. High-frequency admission peaks were statistically significantly reduced for ED admissions. The statistically significant increase in DBN rate is sustained at 35%.

CONCLUSIONS: Increasing the DBN rate correlates with admissions arriving earlier in the day and reductions in high-frequency peaks of ED admissions. Statistically significant improvements in DBN rates are sustainable. *Journal of Hospital Medicine* 2015;10:664–669. © 2015 Society of Hospital Medicine

It is thought that late afternoon hospital discharges create admission bottlenecks in the emergency department (ED).[1] As hospital occupancy increases, so too does ED boarding time.[2] Increased ED boarding time can result in increased length of stay (LOS)[3] and reduced patient and staff satisfaction.[4] Early in the day discharge programs are intended to improve hospital throughput.[5–9] Yet, ED admission timing is, in part, determined by external fluctuations in ED volume and acuity that early discharges do not impact.[10] We previously reported that high levels of discharge before noon (DBN) from inpatient medicine units is achievable through a multidisciplinary intervention.[5] We now evaluate the effect of this intervention upon admission patterns and the sustainability of the DBN initiative.

The DBN intervention consisted of afternoon interdisciplinary rounds, a checklist of team members' responsibilities, a standardized electronic communication tool, and daily feedback on the DBN rate.[5] The intervention resulted in an increase in the DBN rate from 11% to 38% in the first 13 months. We previously reported effects upon the discharged patient as measured by the observed to expected length of stay (O:E LOS) and 30-day readmission rate. We now assess the effect of our DBN initiative on the subsequent patient and hospital throughput. Our objectives for this study were: (1) to determine the effect of DBN on the admission arrival times and admissions per hour to the units, and (2) in a separate data collection and analysis, to determine if the increased DBN rate is sustainable. We hypothesize that DBN results in admissions arriving onto the units earlier in the day. We further hypothesize that because of this redistribution, DBN will level the load of admissions, reducing admissions per hour peaks that can occur late in the day.

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METHODS

Study Design, Participants, and Setting

This is a pre-/postretrospective analysis evaluating the effect of a previously described DBN intervention.[5] Two inpatient acute-care medicine units at NYU Langone Medical Center's Tisch Hospital, a 725-bed, urban, academic medical center, were included in the analysis. All patients admitted to the units underwent the intervention.

Intervention

The DBN intervention began with a multidisciplinary kickoff event in which all team members received education on the importance of DBN, a clear description of roles in the DBN process, and a corresponding checklist of responsibilities. The checklist was utilized at new afternoon interdisciplinary rounds intended to identify next-day DBNs. Patients identified in afternoon interdisciplinary rounds were logged in a DBN website that generated twice-daily automated emails to communicate the planned DBN list to frontline staff and key stakeholders. Daily, real-time feedback on the DBN rate was provided to floor staff.

Measures

Admission Arrival Time

The arrival location and time to any hospital area (ED, radiology, inpatient medical unit) is recorded in the electronic medical record (Epic, Madison, WI) at the time the patient arrives by the patient unit assistant or unit clerk. We obtained the arrival time to each hospital unit throughout the patient's hospitalization for all patients arriving to the study units during their hospitalization between June 1, 2011 and March 4, 2012 (the baseline period) and March 5, 2012 and June 31, 2013 (the intervention period). Data from October 25, 2012 to the end of January 2013 were excluded due to hospital closure from Hurricane Sandy. These time periods and exclusions match those used in our previous DBN article.[5] To match that study's criteria, we excluded patients on the units in the patient class "observation," inpatient hospice, and those patients whose discharge disposition was "expired" or "hospice."

ED Admissions

All patients with a first inpatient unit location of ED and no other inpatient unit location prior to arrival on the study units were included in the ED admission analysis. Units that treat but do not provide long-term boarding/housing of inpatients—such as radiology, hemodialysis, and cardiac catheterization—were not considered in determining ED admission status. Even if a patient had recorded arrival to those areas between ED and study unit arrival, these patients were considered ED admissions, as they were never admitted to another inpatient unit.

Transfers and Direct Admissions

All patients whose first inpatient unit location was the study units were included in the transfers and direct admissions analysis. Those patients who were recorded as coming from another inpatient unit (such as another medical, surgical, step-down, intensive care, or other specialty unit) prior to study unit arrival were included as intrahospital transfers.

Level Load of Admissions

Level loading is a lean methodology term that describes reducing the "unevenness" in a production line to enhance efficiency.[11] We evaluated this by comparing the admissions per hour (density distribution) to the studied units in the pre- and postintervention periods.

Sustainability of the DBN Intervention

The DBN intervention, as described in our original article, continues uninterrupted. Using the same methodology, inclusion criteria, exclusion criteria, and data analysis previously described, we gathered the discharge date and time as recorded by the patient unit assistant for all patients discharged from the study units for the 18 months (July 1, 2013 to December 31, 2014) after our original article to evaluate the sustainability of our improvement in DBN rates.

Statistical Analysis

Median admission time to the floor was compared between the 2 time periods using the Wilcoxon rank sum test. This is a non parametric test of the null hypothesis that the two time periods have the same distributions of admission time to the floor. To evaluate statistical significance, each admission time is arranged in order of magnitude and assigned a rank. The sum of the ranks for each group is calculated and the smaller rank sum (the W statistic) is compared to an expected range of values based on the sample sizes. If this value is out of range then one can reject the null hypothesis. The density distributions of admissions during the 2 time periods were compared using the Kolmogorov-Smirnov test. The 2-sided Kolmogorov-Smirnov test evaluates the maximum distance (D) between the distributions of 2 samples.[12] We chose this test because it evaluates differences between both the position and shape of the distributions of the samples.

RESULTS

Setting Characteristics

The units had an average occupancy rate of 86.8% for the duration of the study. The average number of total discharges per day was 9.8. The average absolute length of stay was 5.6 days.

Admission Arrival Time to the Unit

ED Admissions

A total of 6566 patients were admitted from the ED to the units, 2756 in the baseline period and 3810 in the intervention period. The median arrival time to the units of ED admissions grouped by hour of the day moved by 1 hour, from 5 PM to 4 PM from the baseline to intervention period, and this change was statistically significant ($W = 16{,}211{,}778$, $P < 0.01$) (Figure 1).

Transfers and Direct Admissions

A total of 823 patients were transferred or directly admitted to the units, 310 in the baseline period and

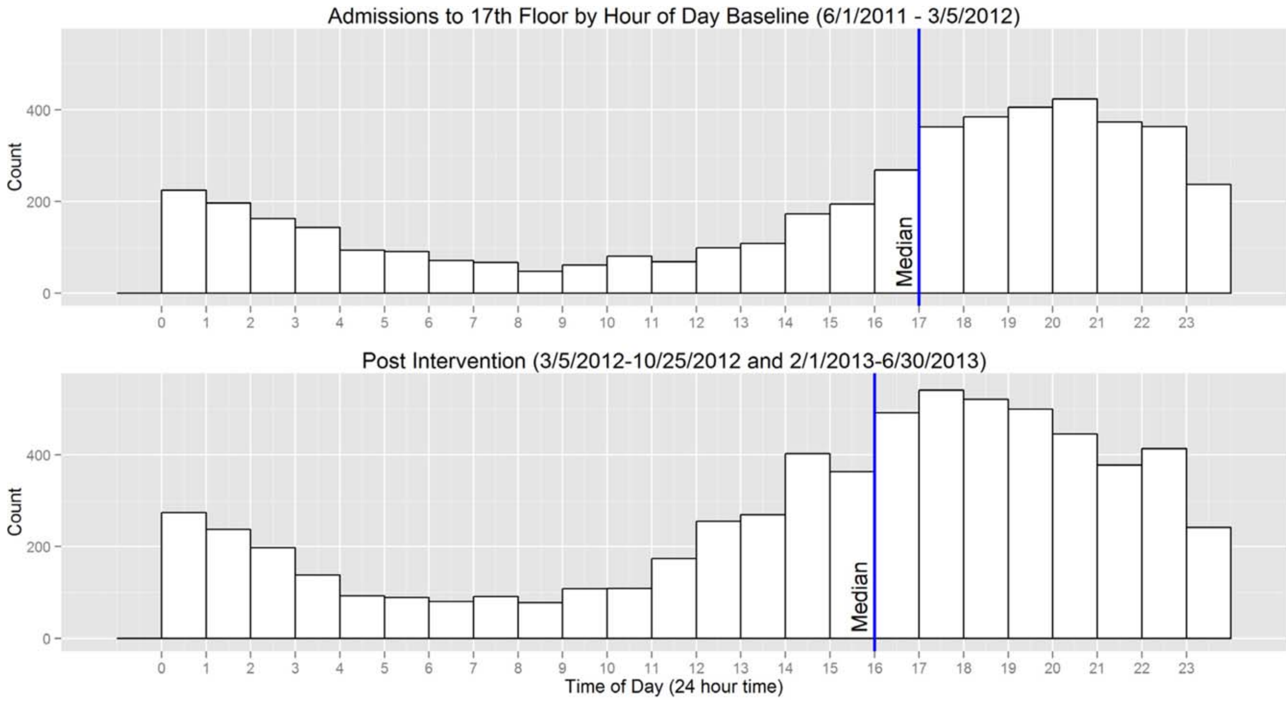

FIG. 1. Timing of admissions from the emergency department by hour of the day. Count = number of patients.

513 in the intervention period. The median arrival time to the units grouped by hour of the day moved 1 hour from 5 PM to 4 PM, and this change was statistically significant (W = 324,532, $P < 0.01$) (Figure 2).

Level Load of Admissions

In the baseline period, the highest density of ED admissions occurred during the 5-hour period from 5 PM to 10 PM, when 42.3% of daily admissions arrived (Figure 3). In the intervention period, the highest density of admissions occurred during the 5-hour period from 3 PM to 8 PM, when 40.0% of daily admissions arrived. The difference between the density distributions for the 2 time periods was found to be statistically significant using the Kolmogorov-Smirnov test (D = 0.03, $P < 0.01$).

In the baseline period, the highest density of transfers and direct admissions occurred during the 5-hour period from 3 PM to 8 PM, when 51.7% of daily admissions arrived (Figure 3). In the intervention time period, the highest density of transfers and direct admissions occurred during the 5-hour time period from 2 PM to 7 PM, when 50.3% of daily admissions arrived. The difference between the density distributions of transfers and direct admissions for the 2 time periods was not statistically significant using the Kolmogorov-Smirnov test (D = 0.04, $P = 0.3$).

Sustainability of the DBN Intervention

For the 18 months after the prior reported DBN intervention period, an additional 5505 total discharges were included for analysis. Of these, 1796 were DBN. The average DBN rate for the study units from March 5, 2012 until December 31, 2014 (the original intervention period plus the additional 18 months of new data) is 35% (Figure 4).

DISCUSSION

The potential effects of DBN are multiple. By reducing the O:E LOS and allowing patients the time to acquire their medications, make follow-up appointments, and ask questions while providers are still in the hospital, our DBN initiative impacts the discharged patient's quality, safety, and efficiency of care.[5] We now report how the DBN initiative potentially impacts the subsequent patient's efficiency of care and hospital throughput. In addition, we show that the DBN initiative is sustainable over years.

Over the same time course as our initial DBN intervention, we found a statistically significant change in the time when admitted patients arrive on the floor. This was true of those patients admitted through the ED and those directly admitted to the floor. In a complex hospital system with many factors both internal (bed cleaning, patient transportation) and external (natural variations in ED volume and acuity) affecting the timing of admissions, it is important to note that increasing the DBN rate correlates with a change in median admission arrival time. From a patient safety standpoint, any initiative that moves admissions away from evening and night hours and takes advantage of (usually more robust) day staffing is a potentially favorable intervention.[13]

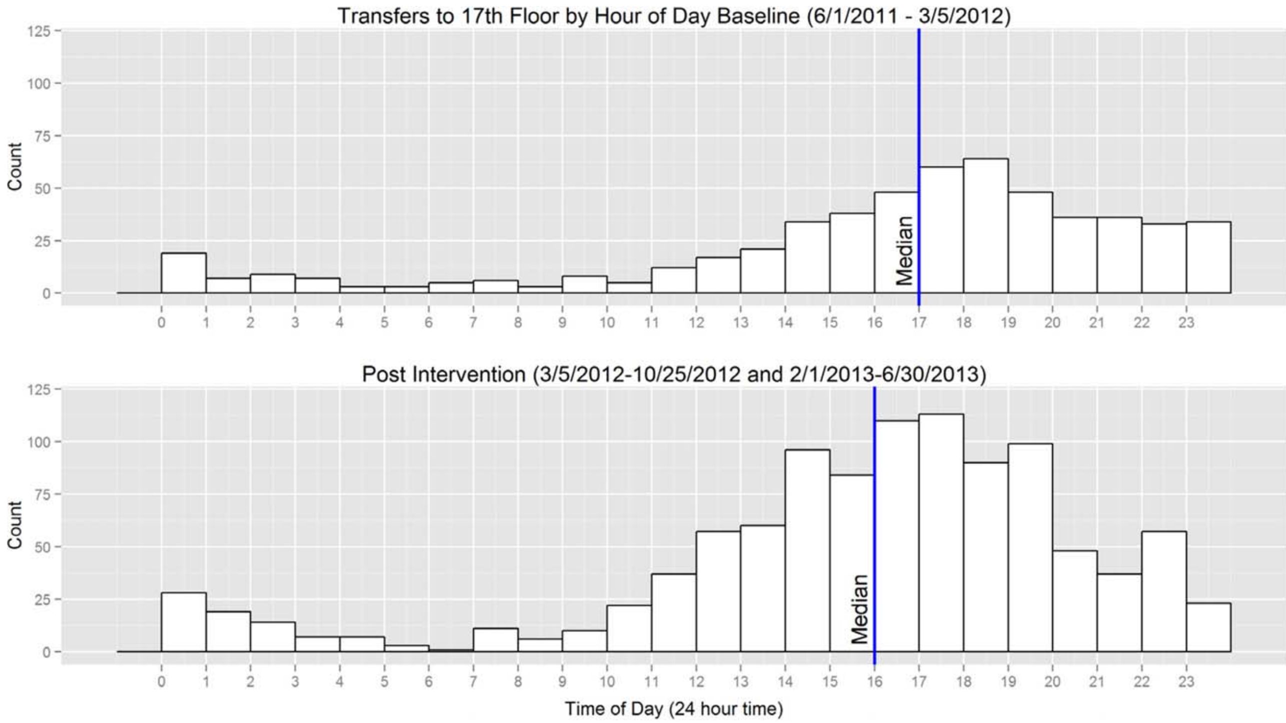

FIG. 2. Timing of transfers and direct admissions by hour of the day. Count = number of patients.

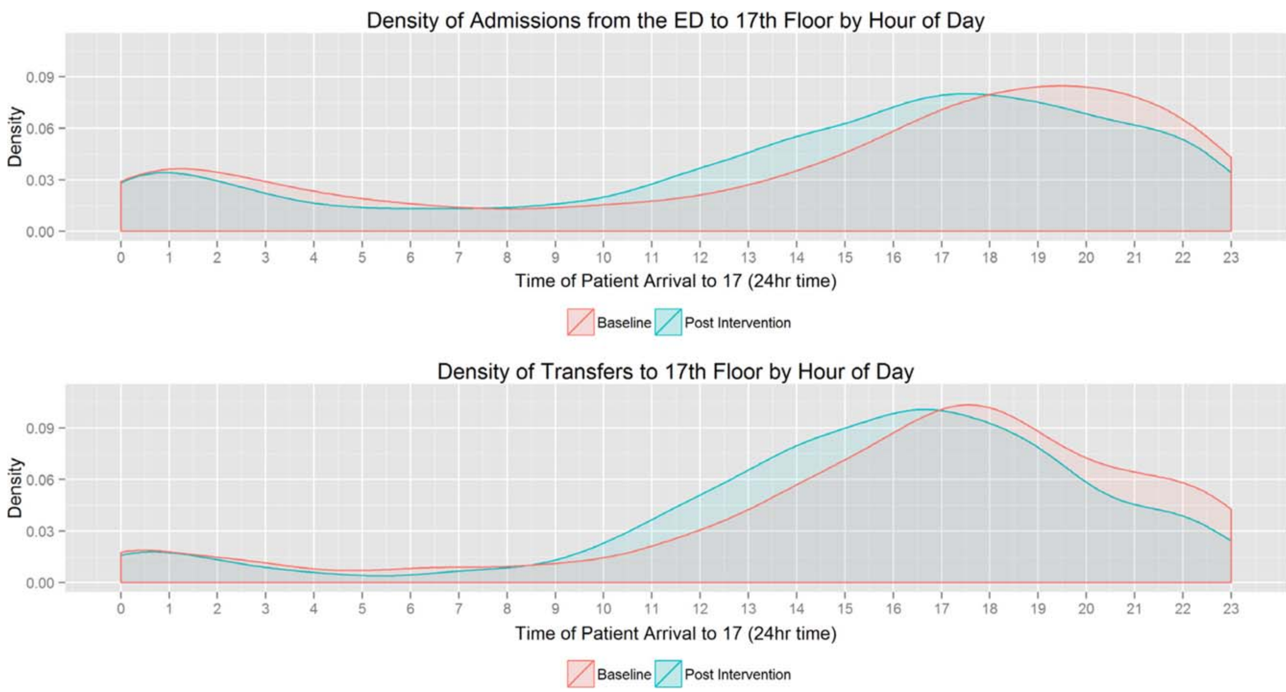

FIG. 3. Density of emergency department (ED) admissions and transfers by hour of the day. Density = number of admissions per hour.

We observed a statistically significant reduction of highest frequency peaks of ED admissions. It appears that opening beds up earlier in the day through DBN may help level the load of admissions from the ED. There was no effect on highest frequency peaks of transfer admissions to the floor. This may be due to the timing of transfers being dependent on factors other than bed availability, such as timing of transportation to the hospital or the timing of planned treatment.

We also found that the DBN intervention has created sustainable increases in the DBN rate. Since our initial publication, we have received direct communication

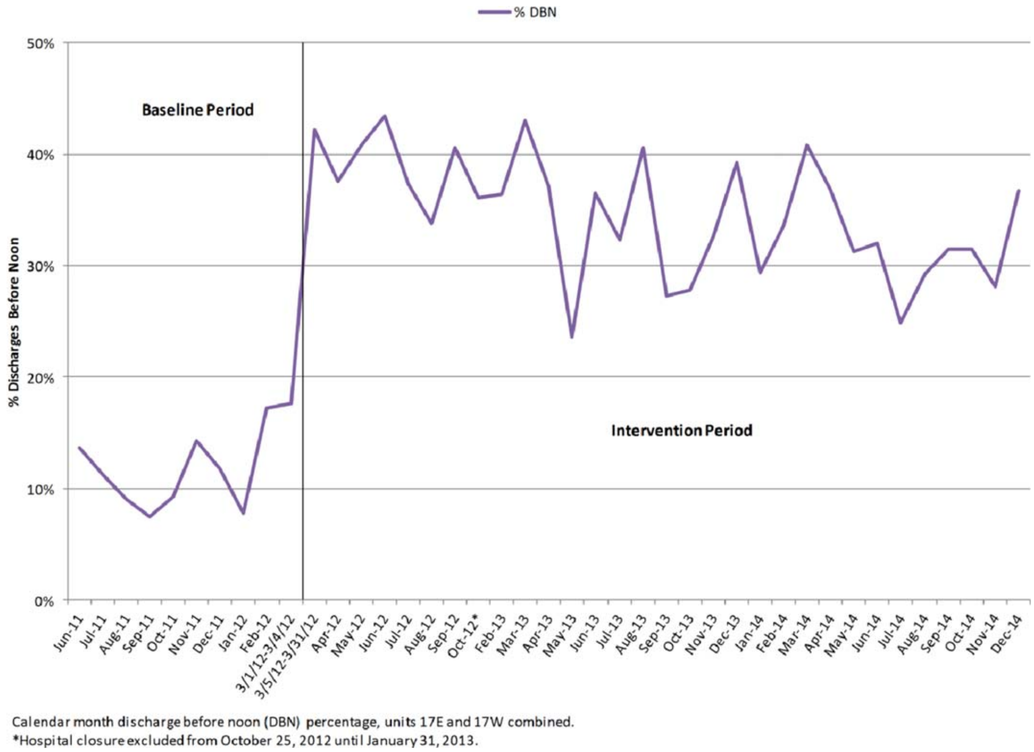

FIG. 4. Calendar month percent discharge before noon (DBN).

from physicians, administrators and managers in 6 different states and 2 foreign countries asking for additional information or reporting that their hospitals are pursuing similar goals. Some of the most common questions asked include: "Are your results sustained?" and "What do you think is a reasonable DBN goal?" We have attempted to answer both of these questions. We previously reported improvement to an average DBN rate of 38% over the first 13 intervention months. With more time, we now see an absolute DBN rate of 35%. In November 2014, we restructured our medicine service to become geographic, so that the same group of doctors, trainees, nurses, care managers, and social workers care for patients on a single ward. Since this initiative, our DBN rate has climbed to greater than 40%. We hope to report further on this new intervention in the future. Similar hospital centers can consider using our experience on an inpatient acute-care medical unit in an urban environment as a benchmark for setting hospital metric goals for early-in-the-day discharge.

Several studies have previously reported on early-in-the-day discharge initiatives. These were smaller studies that focused on descriptions of the type of intervention, including a discharge brunch on an obstetrics floor,[8] scheduled discharges,[6] in-room displays of expected day and time of discharge,[9] and a physician-centered discharge process.[7] Our study is substantially larger, focused on inpatient medicine units, and reports the effect of significant changes in DBN on patient and hospital metrics.

Our study had several limitations. The study is based in a single site, potentially limiting the generalizability of our findings. The hospital underwent tremendous change during the course of the intervention, including its temporary closure due to Hurricane Sandy. We cannot exclude effects related to shifts in volume and possible differences in the pre- and post-time period patient populations. The prior study evaluated the population of discharged patients, but the admission analysis in this study involves the population of admitted patients. There may be slight differences in the populations due to the inclusion of patients who were admitted but not discharged from the units (for instance due to transfer after admission). Though the findings on admission arrival time correlate well with the increasing DBN rates, as they occur during the same time and in the same direction (earlier in the day), we are unable to conclude if the effect is causative. There were many interventions ongoing throughout the hospital to improve throughput, and these programs could have created local trends that confound our data. We are also unable to evaluate the clinical significance of a 1-hour shift in median admission arrival time. Each hospital system must determine for itself if the time and resource investment in DBN is worth the change in admission timing described. We completed this analysis with the perspective of the inpatient medical unit experience, including the timing and number of admissions arriving to the units. We cannot exclude the possibility that changes in arrival times or boarding trends in the ED contribute to our findings.

CONCLUSION

In our hospital, a successful DBN initiative correlates with movement of ED admissions and transfers onto the inpatient units earlier in the day. There was a leveling of the load for ED admissions over the same time period. DBN continues to be an achievable hospital goal, and we provide a potential benchmark for similar hospitals.

Disclosure: Nothing to report.

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