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Brief Communication

# Determinants for Predicting Number of Discharges in a Tertiary Care Hospital

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**Abstract**

Minimum variance in hospital census canlead to better utilization of bed capacity without creating an overflow situation. Identifying determinants of discharge predictions combined with the scheduling of patients for admission according to the prediction is one of the ways to ensure minimum census variance. Objective - This quantitative study attempts to investigate the presence of 'Weekend Effect' and other determinants for predicting number of discharges in next 24 hours. Admission control system data of patients admitted in a 200 bed hospital in Pune was analysed from 1 Jan 2015 to 23 July 2015 (204 days). Length of Stay (LOS), census, and weekends were included for analysis. Saturday, Sunday, Monday were clubbed together as weekend and remaining days considered as weekdays. Dichotomous frequency values were created using the values above and below the third quartile for each variableand used to compute the odds ratio. Admission date-time and discharge date-time of 9039 patients was collected of which 3792 patients with LOS less than 24 hrs were removed. Remaining 5247 patients were further analysed. Mean number of admissions and discharges was 25,130 was mean census and mean TLOS was 742 days. out of the 200 available beds around 130 were regularly occupied which shows that around 65% of the total bed capacity was being utilized.The probability of $\leq$ 30 patients getting discharged was 4.89 times more likely when census was $\leq$ 137, 2.47 times more likely if day of discharge was a weekend and 2.23 times more likely if TLOS was $\leq$ 886 days. We conclude that number of discharges is determined by daily census, TLOS and day of the week. Further, strong 'Weekend Effect' was observed to be a determining factor for discharge prediction.

## Introduction

A steady patient census in hospitals, in other words minimum variance in census, leads to increase in average bed occupancy levels without increasing the probability of an overflow situation [1]. Moreover, since hospitals, in general, staff for maximum census levels, reducing census variance increases the economies of scale through better utility of manpower.

Sensibly, census variance can be minimized by admitting exactly the same number of patients as are discharged on each day. In practice, this simple idea is very difficult to accomplish since the number of discharges and a portion of the number of admissions (emergency admissions) are stochastic (random) variables [2].

Admissions control systems use two different methods to help reduce census variance [3]. The first method is to wait each day until the number of discharges is known and then to call in an appropriate number of patients from a waiting list. The second method involves identifying variables that prediction of future discharges, combined with the scheduling of patients for admission according to the prediction. Although the distribution of discharges is different in each hospital, certain characteristics of discharge distributions are common to almost all hospitals, especially the "Weekend Effect" [4,5]. However, such studies are rare in an Indian setting where non-clinical variables are analysed to identify determinants for predicting discharges. This quantitative study investigates the weekend effect and identifies such factors that have a determining effect on number of discharges that will take place in next 24 hours.

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## Methods

### *Study Design and Setting*

This study was conducted using quantitative tools by capturing admission control system data of patients admitted in a 200-bedded super-speciality hospital in

Pune city between 1 Jan 2015 to 23 July 2015 (204 days).

### *Study Procedure*

After taking permission from the hospital authorities, admission date-time and discharge date-time of all patients was collected, irrespective of the ward in which they were admitted. This data was collected from the proprietary HMIS software that the hospital used.Length of Stay (LOS) was computed using the admission date-time along with discharge date-time. Patients with LOS less than 24 hrs were removed from the further study since hospital admission control systems have a different process for day-care admissions.Study variables,that were analysed for remaining patients,included admissions in last 24 hours, Bed Occupancy, Total LOS of Admitted Patients, and number of actual discharges planned fornext 24 hours.Following assumptions were made:

(a) Deaths were considered as discharges,

(b) Re-admissions were considered as fresh new admissions and not a continuation of previous admission.LOS of all admitted patients (noted as census for that day) was calculated and added up to find the TLOS.

For instance, TLOS of all admitted patients on 10 Jan 2015 at 7:00 pm was 743.21 days.

### *Data Analysis*

The data collected between 01 Jan 2015 to 23 July 2015 (n = 204) was analysed using IBM-SPSS (ver. 23.0). The independent variables were evaluated as determinants for predicting numbers of discharges on subsequent day.

Further, dichotomous frequency values were created using the values above and below the third quartile for each and used to compute the odds ratio. For further analysis, Saturday, Sunday, Monday were clubbed together as weekend and remaining days considered as weekdays to analyse the 'Weekend Effect'. The frequencies obtained were used to calculate the odds ratio.

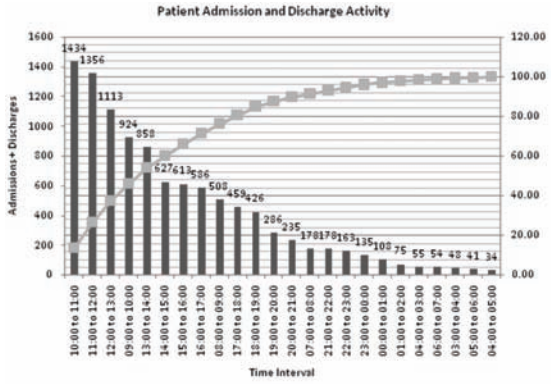


Figure 1: Hourly distribution of the admission and discharge time

## Result

Admission date-time and discharge date-time of 9039 patients was collected, irrespective of the ward in which they were admitted. 3792 patients with LOS less than 24 hrs were removed from the further study since hospital admission control systems have a different process for day-care admissions. The data of remaining 5247 patients was further analysed. A Pareto analysis of the admission time and discharge time of the remaining 5247 patients was done to decide the ideal time to make coming 24-hr predictions.

As can be seen from Fig. 1, nearly 85% of the hospital admissions and discharges activity in all IPD wards were accomplished between 8 a.m. to 7 p.m. Hence all hospital metrics described above were captured at 7p.m. every day.Descriptive Statistics for the study variables are presented in table 1.

**Table 1: Descriptive statistics of study variables**

| Descriptive Statistics | | | | | |
|---|---|---|---|---|---|
| | | **Discharges** | **Admissions** | **Census** | **TLOS** |
| **Total count for 204 days** | | 5125 | 5099 | - | - |
| **Mean of Daily Counts** | | 25.12 | 25.00 | 130.65 | 742.65 |
| **Median of Daily Counts** | | 27.00 | 25.00 | 130.00 | 726.76 |
| **Std. Deviation** | | 8.39 | 7.09 | 9.92 | 168.63 |
| **Range** | | 39.00 | 34.00 | 53.00 | 613.10 |
| **Minimum** | | 3.00 | 8.00 | 105.00 | 459.20 |
| **Maximum** | | 42.00 | 42.00 | 158.00 | 1072.30 |
| **Percentiles** | **25** | 21.00 | 20.00 | 124.00 | 598.28 |
| | **50** | 27.00 | 25.00 | 130.00 | 726.76 |
| | **75** | 30.00 | 30.00 | 137.75 | 886.42 |

**Table 2: Linear regression results to identify significant independent variables**

| | Unstandardized Coefficients | | Sig. (p-value) | 95% Confidence Interval for B | |
|---|---|---|---|---|---|
| | Beta | Std. Error | | Lower Bound | Upper Bound |
| (Constant) | -1.99 | 4.78 | 0.68 | -11.41 | 7.43 |
| Sun | -15.01 | 1.00 | <0.001 | -16.98 | -13.05 |
| Mon | 6.54 | 0.96 | <0.001 | 4.64 | 8.43 |
| Sat | 3.81 | 0.92 | <0.001 | 1.99 | 5.63 |
| Census | 0.25 | 0.04 | <0.001 | 0.17 | 0.33 |
| TLOS | -0.01 | 0.00 | <0.001 | -0.01 | 0.00 |
| Dependent Variable: Actual Patient Discharges in Coming 24 hrs | | | | | |

**Table 3: Results of logistic regression to compute unadjusted Odds for predicting discharges in next 24 hours**

| Variables | | Actual Next Day Total Discharges | | Odds Ratio | 95% Confidence Interval | | p-value |
|---|---|---|---|---|---|---|---|
| | | ≤30 Patients | >30 patients | | Lower Bound | Upper Bound | |
| Census | ≤137 | 131 | 22 | 4.89 | 2.39 | 9.97 | <0.0001 |
| | >137 | 28 | 23 | | | | |
| Day of the Week | Weekend (Sat-Mon) | 99 | 18 | 2.47 | 1.25 | 4.87 | <0.001 |
| | Weekdays (Tues-Fri) | 60 | 27 | | | | |
| Total LOS | ≤886 days | 125 | 28 | 2.23 | 1.09 | 4.54 | <0.05 |
| | >886 days | 34 | 17 | | | | |

As can be observed, out of the 200 available beds around 130 were regularly occupied which shows that around 65% of the total bed capacity was being utilized.Authors questioned that if determinants for predicting discharges can be identified then average number of admissions, based on the accurately predicted number of discharges,can be utilized to ensure throughput of patients across the system. This will ensure utilization of the unused bed capacity without creating any overflow situation. Out of the 204 days included in the study, each of the week days occurred 29times except for Friday which was 30 in count. Each day of the week is thus adequately represented to rule out any bias or any special days of the week that might skew the distribution of the values of the dependent variables.

As is evident from table 2, weekends, census and TLOS significantly predict the number of discharges in next 24 hours.

Thus, the probability of less than or equal to 30 patients getting discharged is 4.89 times more likely when census is ≤137, 2.47 times more likely if day of discharge is a weekend and 2.23 times more likely if TLOS is ≤ 886 days.

## Discussion

The aim of the present study was to identify determinants for predicting discharges fornext 24 hours.We found that 85% of the hospital admission and discharge activity in all IPD wards were accomplished between 8 AM through 7 PM. Therefore, this is the ideal time to capture the relevant data for analysis. We found that on an average around 65% bed capacity was being utilized. It is this vacancy that we can try to fill up by predicting discharges and scheduling admissions for the next day.

The primary objective of most hospital admissions scheduling or admissions control systems is to reduce the variance in the daily patient census. Existing bed demand enables hospitals to increase bed occupancy without creating an overflow situation. Literature shows that admission control systems use two different methods to help reduce census variance [3,6,7]. The first method is to wait each day until the number of discharges is known and then to call in an appropriate number of patients from a waiting list. The second method involves prediction of future discharges, combined with the scheduling of patients for admission according to the prediction. Potential benefits of the latter method are substantial.

Such a system can be highly useful for surgery-focused hospitals [9]. Patient can get admitted during the evening one day prior to the scheduled surgery and undergo all preliminary investigation thus saving time on pre-surgery routines. Thus, besides patient and physician satisfaction, scheduling also allows patients to become part of a Pre-Admissions Testing (PAT) program [8].

Mean and median for the 4 variables namely, admissions, discharges, census and TLOS were equivalent in our study showing little dispersion in the data. Furthermore, in our study, census and TLOS played a significant role in determining the number of discharges for next 24 hours. Previous studies have also studied LOS to determine probability of discharge in coming days [10-12]. However, this method involves errors in the associated discharge predictions as shown in previous studies [13]. Attempts to predict hospital discharges or identify determinants are well documented in the literature which is done through either physicians' or nurses' to estimate the date of discharge[14]. With increasing use of Hospital Management Information Systemstudies one can expect increase in such data-intensive researches.However, we could not find any such studies that describes the effect of Census and Total Length of Stay of Admitted Patients on explaining the discharge patterns.

We observed a weekend effect as discharges varies significantly when day of discharge was between Saturday-Monday. Our finding of existence of "Weekend Effect" as a determinant of discharge predictions is corroborated by past studies [4,5]. It has been shown that the day of week significantly affects the admission and discharge patterns in hospitals and that there exist distinctive patterns of admissions and discharges by day of the week. However, there is a little difference in the findings. The past study shows that the day with fewest discharges was always Monday and the day with the greatest number of discharges was always Saturday [4]. Whereas in our study, the day with fewest discharges was always Sunday and the day with greatest number of discharges was always Monday followed by Saturday.

Most of this pattern in our study is a result of hospital policies. Like, surgeries were scheduled only for 5 days per week, insured patient discharges not done on Sundays, patients and/or physicians preferred Monday followed by Saturday as discharge day. Further there exists a tendency to discharge relatively stable patients on Saturday. On Mondays, the above reasons continue to exist in addition to which there is an added pressure to make room for new patients.

The strength of our study is that we attempted to identify the determinants of predicting dischargesin India through a highly data-intensive research which captured data of more than 5000 patients over little less than 7 months. Further, our study adds to the rare Indian studies that have reported 'Weekend Effect' as a determinant of discharge predictions.

Limitation of our study is that while we may predict the total number of patients getting discharged in next 24 hours, one cannot know exactly which patient is going to be discharged. Further, we have not included clinical data and individual patient discharge predictions is not done. Moreover, when a wider variety of data type (clinical and non-clinical) is analysed, one would find more discharge explainers that will increase accuracy of predictions. However, in our study only administrative variables are used to analyse discharge trends.

Nevertheless, our study shows that using the determinants it is possible to predict discharges in next 24 hours.

## Conclusion

We conclude, that number of discharges is determined by daily census, TLOS and day of the week. Further, strong 'Weekend Effect' was observed to be a determining factor for discharge prediction. However, future studies should focus on analysing administrative variables combined with clinical variables as determinants for discharge prediction particularly in Indian set up.

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|---|---|
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