Flexing Bed Stock : A Hospital Capacity Management Case Study

Sankalp Khanna, Justin Boyle, Kathryn Zeitz

Abstract— **As hospitals struggle to meet rising demand for their services, efficient capacity management is critical to the success of their efforts. A popular strategy employed by hospitals to meet the variability in demand for their services is to 'flex' their capacity, i.e. to vary the number of available staffed beds to suit demand on a regular basis. This study uses data from a large tertiary hospital in South Australia to analyze the efficacy of their flexing protocols and the impact of flexing capacity on overcrowding. We also analyze the impact of variation in occupancy on patient flow parameters and compare this to previous studies conducted on similar sized Australian hospitals that do not flex capacity. Our findings reveal that flexing capacity helps the hospital spend less time over critical occupancy levels, and that the hospital does not show the signs of performance decline exhibited by hospitals that do not flex capacity. Areas for improvements in the flexing protocol and possible strategies are also identified. The findings support the use of flexing capacity as an efficient protocol and will serve as a useful guide for services seeking to improve existing capacity management protocols.**

I. Introduction

Hospitals around the world are struggling to cope with the challenges of ageing populations, reduced budgets and resource shortages. The pandemic of overcrowding continues to live up to its 'International Crisis' reputation, linked to poor patient outcomes, increased waiting times, reduced safety and unnecessary mortality [1][2][3][4][5][6].

The need for a 'whole of hospital approach' to combat overcrowding is well established, and better capacity management and improved discharge planning are recognised as 'high impact solutions' to alleviating overcrowding in hospitals. Popular mechanisms employed include capacity management plans [7][8], census alerts [9][10][11] and the use of surge/flex capacity [12][13]. The Australian Institute of Health and Welfare defines Surge Beds and Flex Beds as representing the increase in the number of available beds by making arrangements for additional nursing and auxiliary staff[1]. In Australia, several hospitals make regular use of this surge capacity to 'flex', i.e. vary the number of available resourced beds to suit bed demand, increasing their everyday capacity to meet patient demand. There is however, to the best of our knowledge, no documented evidence empirically validating the efficacy of 'flexing' bed stock to meet expected variations in bed demand. This study is designed to analyze the efficacy of their flexing protocols and their impact on overcrowding.

The Royal Adelaide Hospital (RAH), South Australia's largest teaching hospital, employs flexing on a regular basis to meet periods of high demand and as a capacity management process to reduce overcrowding. The hospital defines capacity using two terms – a Base Bed Capacity that represents the total resourced general bed capacity for the hospital, and a Flex Bed Capacity, that represents the number of additional general beds for the hospital that can be used if appropriate levels of nursing staff can be made available to care for the additional patients.

In this study, we analyse the base and flex capacity of the hospital over a two year period to analyse the efficacy of the flexing protocol in meeting demand for beds and the impact on overcrowding. Previous studies have identified that hospitals exhibit three stages of system performance decline, or choke points, as occupancy increases [14]. We analyse flex capacity as a function of hospital occupancy to identify if flexing capacity helps the hospital overcome these conventional flow blockages and alleviate overcrowding.

II. Methods

Retrospective analysis of patient flow data from inpatient databases in the Patient Management System from the RAH was performed. The study period for patient flow analysis was 24 months (July 2009 – June 2011). Ethics approval for this study was obtained from the RAH Research Ethics Committee.

Patient record data was aggregated into hourly intervals, and these hourly interval 'slots' were used as a common index on which patient flow parameters from different datasets were measured, visualised and compared (as suggested in [15]). Two different measures were used to calculate occupancy across these hourly intervals. Occupancy was calculated as the ratio of occupied beds to census beds (i.e. base capacity). Occupancy was also calculated as the ratio of occupied beds to flex capacity. For the purpose of this study, the measures were referred to as Base Occupancy and Flex Occupancy respectively.

Daily patient flow was calculated from this hourly information. Variations in flow parameters as a function of varying flex occupancy were measured and compared to identify interdependencies. Information measured included time spent at various inpatient occupancy levels, inpatient admission and discharge rates, emergency department (ED) presentation and discharge rates, ED length of stay for admitted and non-admitted patients, and the inpatient length

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[1] http://meteor.aihw.gov.au/content/index.phtml/itemId/373634 (last accessed June 2014)

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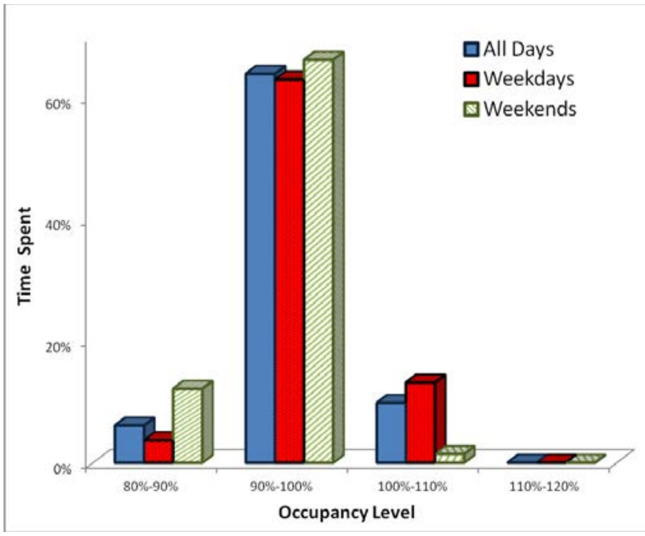

Figure 1. Time spent at various flex occupancy levels

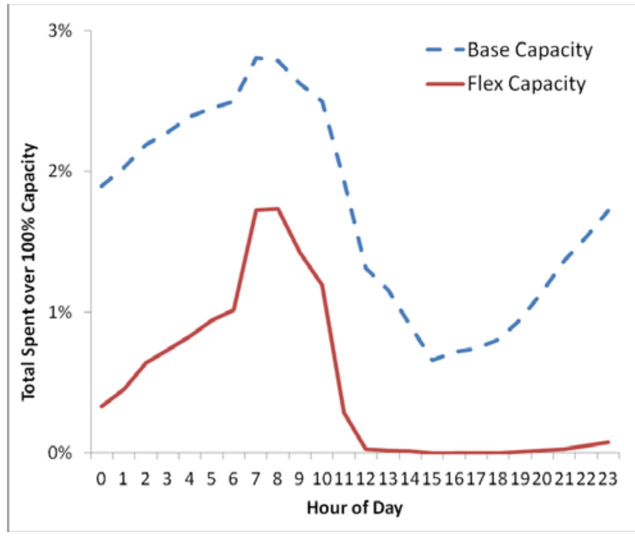

Figure 2. Time spent above 100% capacity as a function of time of day

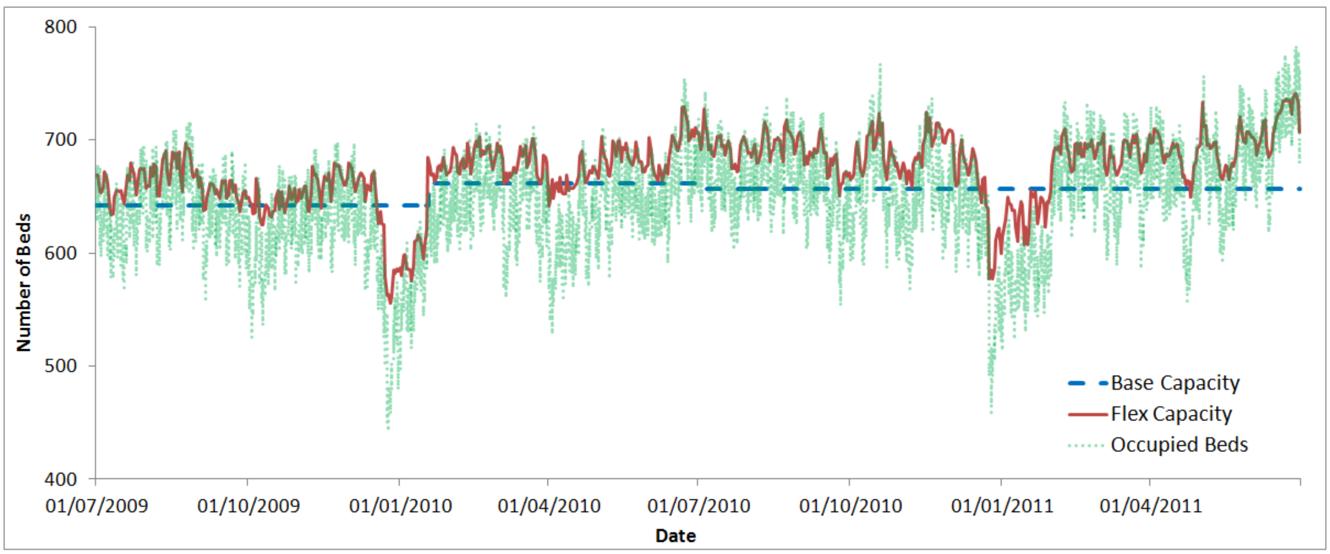

Figure 3. Hourly capacity and bed utilization

of stay for admitted patients. This was then overlaid and plotted against corresponding hourly flex occupancy to allow analysis of system performance at varying levels of overcrowding as suggested in [14].

III. RESULTS

The time that the hospital spent at various flex occupancy levels is presented in Figure 1. Most of the time was spent at between 90% and 100% occupancy, indicating that the capacity was being utilized efficiently. While the hospital, on average, spent just over 16% of its time above 100% occupancy on weekdays, this was reduced to less than 2% on weekends.

At a daily level, the hospital spent on average 42% of its time with the mean occupancy higher than the base capacity, while less than 2% of its time was spent with mean occupancy above the flex capacity. When analyzed at an hourly level to account for occupancy peaks and troughs across the day, the hospital spent more than 41% of its time over the base capacity, but only 11.5% of its time over the flexible capacity, most of it being before noon (see Figure 2. Note the figure only shows data for when occupancy is greater than 100% capacity).

Figure 3 represents the hourly occupancy snapshot plotted alongside the flex and base capacity of the hospital. The analysis captured the occupancy peaks and troughs across the day and revealed that the actual bed utilization varied by more than 10% from planned flex capacity for less than 8% of the time, as compared to over 12% of the time when compared with base capacity. Occupancy levels measured lower since most of the flexing comprised of adding beds to the base capacity instead of closing them (see Table I).

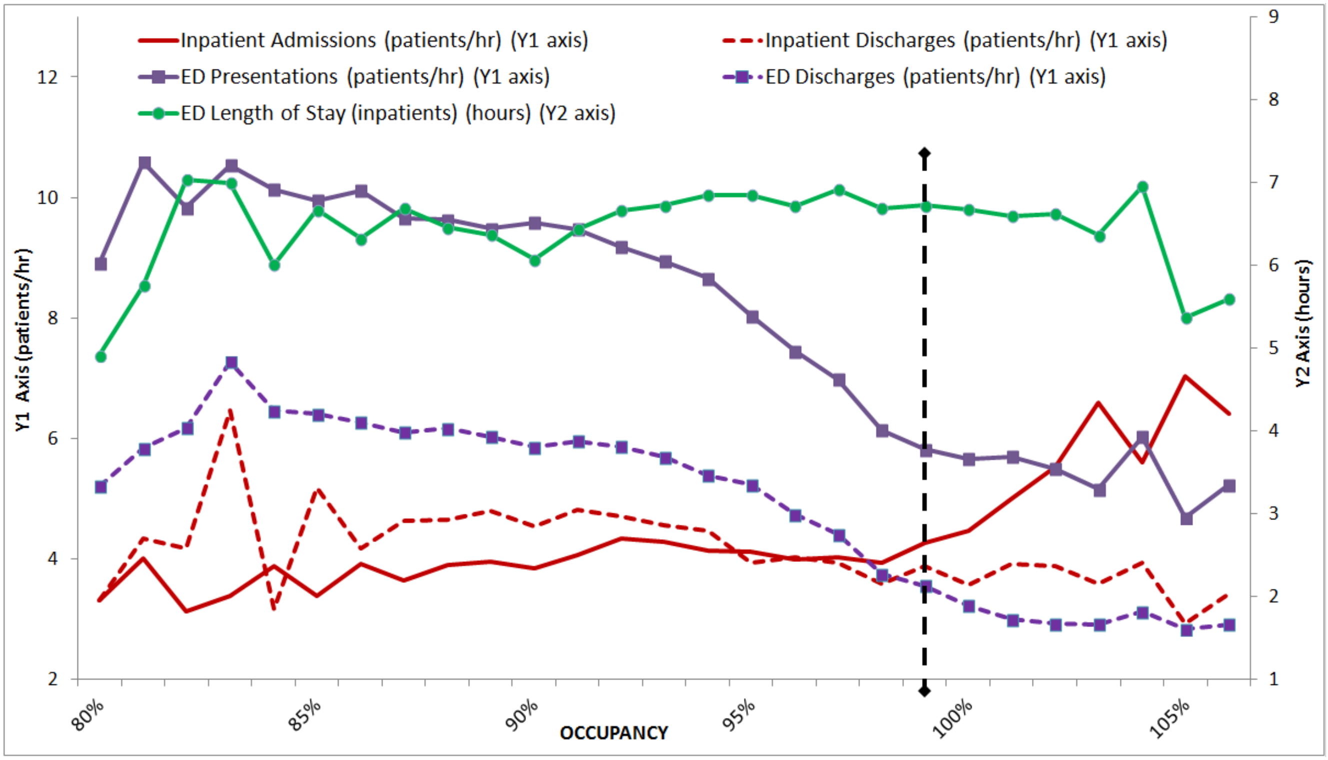

Figure 4. Patient flow as a function of occupancy defined using flexible capacity. The dashed vertical line at 99% occupancy represents a decline in flow performance where the rise in the rate of inpatient admissions is not tracked by the rate of inpatient discharges.

TABLE I. OCCUPANCY DIFFERENCES – BASE VS FLEX CAPACITY

Occupancy Metric	Using Base Capacity	Using Flex Capacity
Mean Casemix	98.02%	95.03%
Mean Midnight	97.70%	94.72%
Mean Minimum	94.53%	91.65%
Mean Peak/Maximum	102.46%	99.34%
Mean Average	98.34%	95.34%

Casemix Occupancy is calculated on midnight utilization reported in hospital databases while Midnight Occupancy is calculated on measured midnight utilization.

Figure 4 presents patient flow parameters, i.e. inpatient admission and discharge rates, emergency department presentation and discharge rates, and ED length of stay for admitted patients as a function of flex occupancy. A decline in flow performance was observed at 99% occupancy, with a rise in the rate of inpatient admissions which was not tracked by the rate of inpatient discharges. Patterns for ED presentations and discharges, and inpatient admissions rates from ED decreased with rising occupancy. ED length of stay for admitted and non-admitted patients and access block (boarding in ED greater than 8 hours for admitted patients) were not affected by variations in occupancy.

IV. DISCUSSION

The time spent at or over the planned capacity, i.e. at high occupancy levels, has previously been shown to be related to poor patient outcomes, including performance decline in patient flow parameters and increased likelihood of adverse events. When considering hourly data, the hospital spent over 41% of its time over the base capacity, but only 11.5% of its time over the flexible capacity. Improved management of capacity using flexing allows the hospital to reduce the time spent over critical levels of occupancy, possibly delivering improved patient outcomes. Given that most of this time above capacity is spent in the morning, efficient patient discharge practices, which have been shown to help reduce occupancy, can help reduce this significantly.

Analysing patient flow as a function of varying occupancy reveals differences in flow as compared to those observed elsewhere [14]. We did not observe patterns evident at other sites, where inpatient admission and discharge rates and ED presentation rates sharply increased with increased occupancy. We speculate that this results from the RAH employing a different approach to managing the release of their flex capacity. Employing the flex protocol thus may help the hospital in overcoming sharp changes in admission and discharge rates.

It was also observed that ED length of stay for inpatients (a measure of boarding) was not affected by rising occupancy. While improved availability of bed stock due to flexing is likely to be a contributing factor, the nature of ED turnover, with reduced presentations and discharges at high hospital occupancy, also possibly contributes to this finding.

A tipping over point of the hospital resulting from inpatient discharges not being able to keep up with rising inpatient admissions is observed (noted by the dashed vertical line in Figure 4), but at high occupancy levels that the hospital spends only 11.5% of the time over. Improving capacity management protocols that help the hospital manage these periods of high occupancy can help alleviate the stress caused by poor patient flow.

Our study explores the regular flexing of bed stock in response to variations in demand for service. It is important to distinguish this from the practise of utilising surge capacity for large and catastrophic levels of unexpected variations in demand [16][17].

Our findings show that flexing hospital bed stock is an effective capacity management strategy for the hospital. The hospital is able to meet bed demand efficiently, spending less time in overcrowded conditions. It improves patient flow and the system does not exhibit some of the chokepoints observed in other similar sized Australian hospitals that do not flex capacity. Our discussions with hospital administrators however revealed that flexing is often employed as a reactive process, and would improve if employed as part of proactive capacity management. Employing reliable prediction algorithms [18] and queuing models [19] to estimate demand, and 'flexing' the number of available staffed beds to meet this expected bed demand can help deliver further improvements to patient flow. We have also previously identified the need for the hospital to improve the efficacy of their capacity alert protocols [11]. These improvements, alongside other flow management protocols such as early discharge initiatives can help significantly reduce overcrowding, improve patient throughput and patient outcomes and reduce unnecessary mortality in hospitals around the world.

The challenge, in this resourced constrained environment, thus is to ensure that flex capacity is not treated as separate from base capacity. The base resourced and available beds need to be able to flex down as well as flex up based on forecasted demand to deliver efficient patient flow.

V. Conclusion

We have analysed the efficacy of 'flexing', i.e. varying staffed available bed stock on a regular basis to meet patient demand, as a hospital capacity management process. Our findings reveal that flexing bed stock allows the hospital to reduce overcrowding and improve patient flow through the service. We also identify the need for hospitals to engage in flexing as a proactive capacity management exercise, improve capacity alert protocols and improve discharge planning, especially to alleviate stress in the morning hours.

VI. Limitations

The study assessed the impact of flexing bed stock at one hospital and in one state that may be seen to have a particular demographic and climatic profile. This should be considered when applying the findings to other hospital service settings.

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