

## General Article

# CAPACITY PLANNING IN HOSPITAL MANAGEMENT: AN OVERVIEW

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## ABSTRACT

Hospital managers can have a special role in health care and life science field because they can effect on society health with their decisions. Forecasting demand and planning capacity for certain health services are complicated tasks due to the inherent uncertainty, complex relationships involved, and usually high public exposure. Generally public hospitals have, more demand for health services than available capacity. Therefore it is important to forecast and manage demand with good precision, in order to adjust capacity or take alternative courses of action.

**Keywords:** Hospital, Capacity, Management, Planning, Patient

## INTRODUCTION

Capacity planning decisions are important to any industry, especially to health care industry because not only it relates to the management of highly specialized and costly resources (i.e., nurses, doctors, and advanced medical equipment), but also it makes a difference between life and death in critical conditions (Hans *et al.*, 2012)

Public hospitals have, in general, more demand for health services than available capacity. Therefore it is important to forecast and manage demand with good precision, in order to adjust capacity or take alternative courses of action for example transfer demand to other facilities.

Demand forecasting and management is part of a larger design that intends to provide a systemic solution to global hospital management. Such solution is commonly based on the design of a general process structure for hospitals and which defines the management processes that are needed to optimize the use of resources in doing so and to ensure a predefined service level for patients. The general process structure allowed us to determine the key processes where implementation of new practices would generate most value (Swayne *et al.*, 2012; Ma and Demeulemeester, 2013)

Healthcare executives and managers are always searching for better ways to improve production capacity for medical treatment and thus, improving operational efficiency. Obviously, many times, capacity in a health care organization is a vague and hard-to-measure concept which varies with local economic conditions and over time (Cardoen *et al.*, 2010). In any hospital, resources are scarce or limited and they are mostly dissimilar in nature. Such dissimilarity nature of capacity for different forms of resources makes the comparison of capacities very important to determine the exact capacity of the system taken as a whole. An inappropriate capacity comparison would lead to inaccurate system capacity and so resulting in inefficiencies in the system – observed in excessive waiting, poor capacity utilization across different resources and poor bottleneck management (Rechel *et al.*, 2010) Therefore, when capacity management is done properly, it can lead to lean service models in healthcare by minimizing almost all the wastage and inefficiencies mentioned above.

## Problem Description

Decisions regarding patient flows consist of the annual or monthly number of patients that can be treated per pathology group, while decisions regarding resources consist of the capacity requirement of each specialty within the hospital. Here the objective is to match patient demands and supplied resources as best as possible. Resources planning and control level with a planning horizon for 3 months to 1 year concerns the decision making at the medium-term level, which consists of time-phased resource allocation and the capacity coordination requirement. Here the objective is to maximally coordinate the utilization of multifold resources (e.g., operating rooms and beds) within the whole hospital. So ignoring

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this coordination may result in capacity losses, for example a poor performance in resource utilization. Therefore, integrating the decision making in both levels is beneficial to produce an efficient patient flow and thus to advance the efficiency of hospital's production.

A hospital might be considered as a production system, in which the limited resources are used to support the patient flow. The demand side of a hospital consists of the many patients with different pathologies that enter the hospital according to their own time map, while the supply side consists on the one hand of the available personnel (e.g., surgeons, nursing staff) and on the other hand of the material resources (e.g., operating rooms, beds). The objective of a hospital is to match its supply and demand side in the best possible way, resulting in a reliable, quick and efficient patient service. Thus, the uncertainty existing in the health care system will play a destructive role for the efficiency of the health service delivery.

However, the uncertainty in the health care systems, both from the arrival process and from the treatment process, not only upsets the resource utilization, but further impacts the patient service level. Therefore, in order to make sound decisions on case mix and resource allocation, it becomes of necessity to incorporate the variability into the capacity planning process.

## **Capacity Planning**

### **General Principles**

Each Specialty team is responsible for proactively managing their admissions and discharges to ensure all anticipated elective and emergency patients can be accommodated with their available capacity. Processes should be in place to ensure that effective management of patient flow and bed capacity is carried out 24 hours per day and 7 days per week.

Specialty teams will work collaboratively with their own Patient Flow Managers, Duty Hospital Manager and Duty Matron who will provide the overview, support and coordination for effective bed use across the Trust. This would be done in a way that balances the risks as whole to accommodate patients' clinical, social, mental health, single sex and infection control requirements.

To reduce the Length of Stay (LOS) in an inpatient bed, the effective discharge planning is really crucial. Discharges must be managed within specialties and divisions, in line with trusts' discharge policy, that is supported by the Discharge Planning Team and over seen by the Modern Matron of the relevant specialty. All patients will have a predicted date of discharge set by medical staff (or nurses in nurse led services) which will be proactively tracked and implemented by medical and ward nursing staff. It must start at pre-assessment for elective admissions and within 12-24 hours of admission for emergency patients.

Divisions and Specialties are expected to adopt a flexible approach to the needs of trust as reallocating resources, like beds and theatre time, within and between Divisions and Specialties, as required to accommodate the interests of the whole hospital patient population. It includes the flexible use of staff when required to ensure safe and effective staffing levels and bed capacity across the hospital as a whole (Green, 2004)

The number of patients selected for elective admissions must be realistic, while taking into account that bed provision should be made for both elective and emergency admissions. Allocating of patients to emergency and elective beds will be balanced to equally meet the demands of both pathways mindful of the national targets that are associated with each.

At times priority will have to be given to emergency admissions, but every effort would be made to avoid the cancellation of elective admissions. Cancellation of elective admissions must only occur once all other avenues for creating capacity have been explored and must be agreed at Divisional General Manager level.

The patient's safety and clinical need are paramount and must be given priority. Normally, patients will be cared for by members of staff who have demonstrated relevant knowledges, skills and competencies.

All efforts will be made to preserve Speciality beds, but it might be necessary to use these flexibly at times of peak demands. It is the responsibility of each Directorate to define clinical limitations on such flexibility (Nguyen *et al.*, 2005)

Every effort will be made to ensure that patients are allocated to beds in a manner that respects their privacy and dignity, and ensures access to their specialty consultant. Not to declare beds, or fill beds in a

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timely manner, is a disciplinary offence. Those beds that become available MUST be notified to the Patient Flow Manager immediately for example when the decision to discharge/transfer has been made and before the bed has been vacated. Once vacated beds should be made ready and available promptly and admissions to empty beds must be facilitated in a manner that ensures beds are not left empty and are filled within the timescales set out in this policy, thus patients can be transferred into them in line with patient flow standards and the prevailing demand requirements.

### *Standards for Patient Flow*

- Predicted Discharge Date to be identified within 12-24 hours of admission with initial treatment plan set out clearly in patients notes
- Patients to be informed of this date and the date to be continuously reviewed as part of the patient's progression of care by both medical and nursing teams
- As care is progressed, action to be focussed on achieving the predicted date of discharge including all appropriate referrals (eg to other clinical specialties, social services, Occupational Therapy) being made in a timely manner to achieve the predicted date of discharge
- Appropriate adjustment to be done to the predicted date of discharge to take account of progression of a patient's condition and the actions necessary to achieve a safe discharge
- Wards to work with Patient Flow Managers to ensure that accurate data is fed into Visual Hospital system and updated on a two hourly period, as well as into Hospital Site Meetings
- Patient Flow Managers to make sure that wards are aware of patients requiring admission from Assessment Units by specialty, infection control requirements;
- The ward staff to work with Patient Flow Managers to create capacity in readiness for the demand of patients requiring admission to their ward
- Continuous communication between wards, Assessment Units and Patient Flow Managers to ensure that information is current and beds are declared and filled promptly
- Wherever possible elective patients to be admitted as a day case; if required in patient beds will be found for patients subsequently requiring in patient admission
- Decisions to open or close bed capacity can only be taken under the direction of the Duty Hospital Manager and/or the On Call Manager, by input from the Divisional Management Team

### *Wards*

Bed capacity should be created to provide beds for both emergency and elective admissions in a way that enables all Trust access targets to be achieved including 4hr target, 18 weeks, thrombolysis.

All wards will aim to identify patients for early morning discharge and maximise the use of the discharge lounge, and as a minimum each ward to identify 1 - 2 named patients for discharge by 11 am. Wards beds to be declared immediately that they are vacant and ward staff will work to make vacated beds ready within the required time of 30 minutes. Once beds are declared to Patient Flow Managers and/or Assessment Units, communication should be maintained until beds are filled.

### *Units of Assessment*

Other than in exceptional circumstances, general practitioner (GP) expected patients will be received directly into the designated assessment and admission units and not normally diverted to the Emergency Department. Such units will work to create capacity to receive both GP expected patients and those from the Emergency Department requiring admission for assessment.

Both units must work with the appropriate Patient Flow Manager to make sure that patients requiring onward transfer to inpatient or other facilities are transferred in a timely manner so that space is kept available on the unit for GP expected patients and those from the Emergency Department.

All these units operate as assessment and short stay units. Patients must not remain on these Units for longer than 48 hours. Ideally speaking, once a patient is identified as requiring transfer to an in patient bed, such a transfer must occur within a maximum of 12 hours. Beds declared to these units must be filled within thirty minutes of declaration and communication with relevant wards should be made if this is not possible. Communication should be maintained until beds are filled.

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Both units will work as part of the Visual Hospital system and will work together with the inpatient floor Visual Hospital to ensure prompt and effective flow between the two. For patients requiring ambulatory or very short stay assessment, trolley and chair spaces must be used in preference to bed spaces.

Patients should not remain on a trolley longer than 4 hours and the same escalation actions should be carried out as for the 4 hour standard that are applied in the emergency department.

#### *Emergency Department*

The Emergency Department will refer to the Assessment Units, Respiratory High Care Unit, Surgical High Care Unit, Intensive Care Unit and any other direct admissions unit in a timely manner, and at the earliest opportunity, thus patients can be transferred within the 4 hour standard, or maybe earlier if a bed is available.

Patients requiring such an admission must be notified to the Assessment Unit Coordinator or Patient Flow Manager as early as possible. Other than in exceptional circumstances it must happen no later than at 3 hours and again at 3.5 hours. Communication should be maintained with the relevant unit to ensure that the transfer occur within the 4 hour standard.

The Emergency Department will admit appropriate patients to the Observation Ward where they require observation and monitoring. Furthermore, appropriate patients may be admitted there who require an in patient bed which is not still available, but for whom admission to an observation bed would make them more comfortable. Patients should not stay in the Observation Ward for longer than 24 hours.

#### *Units of Day Care*

Patients will be admitted to day care units as set out in the relevant operational policy. The Nurse In Charge of the unit should notify the appropriate Patient Flow Manager if a patient requires in patient admission subsequent to their day care treatment.

At the times of pressure these beds may be used to admit patients requiring in patient care as a way to commence their admission when an in patient bed is not still available. Any such decisions will be made in collaboration with the appropriate clinicians.

At times of pressure it may be necessary to use day care facilities overnight to balance pressure either within the Division or across the hospital as a whole. It will be directed by the Duty Hospital Manager in a manner that aims to protect the next day's day care admissions. Such action will only be taken in collaboration with the relevant Specialty or Divisional team.

#### *Units of High Care*

Patients will be admitted to high care units as set out in the relevant operational policies. The Nurse in Charge should notify the appropriate Patient Flow Manager when a patient needs to transfer from the unit, giving appropriate advance notice, thus an appropriate bed can be detected. It must be done proactively to ensure that both the high care unit and in patient wards can effectively manage their anticipated demand.

#### *Principles for Discharge Program*

- Every wards to identify 1 to 2 named patients for definite discharge prior to 11 am with TTO (To Take Out) and Spell Summary done the day before.
- Predicted Date of Discharge to be confirmed the day before, with patients made ready for discharge prior to 1pm on day of discharge
- Nurse in Charge of every wards to work with medical teams to ensure that these named discharges are identified and associated action is taken to ensure they are proactively managed.
- If more discharges are confirmed on the day, spell summaries and drug charts to be written up promptly and drug chart sent to Pharmacy urgently, designating required time for TTO's to be available
- Default position for majority of patients is that they will be transferred to the Discharge Lounge at the earliest opportunity on the day of discharge to free up ward beds and patients should be informed of this by ward staff
- Named patient discharge plans to be set out each Thursday and continually throughout the weekend to achieve continuous creation of capacity. The Nurse in Charge of every wards to ensure that such discharge plans are followed through and identify to the Patient Flow Managers if any support is required to achieve these discharges.

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### **Buffer Capacity**

Sometimes it is necessary to open additional buffer capacity. Ideally speaking it will be avoided by expediting actions to increase discharges to create additional capacity.

The need to do this must be agreed by the Patient Flow Manager, with the Nurse In Charge of the ward under the direction of the Duty Hospital Manager.

Then the appropriate Specialty team will be responsible for detecting proper patients to be transferred to such capacity.

The actions required to open buffer capacity are contained both in the Buffer and Outlier Capacity Policy and the Trust Escalation Plan. Such plan will be kept current in terms of the specific location and nature of buffer capacity that could be use.

### **Problem Statement**

The situation taken up in this paper is a conceptual case. We define our case as follows:

- number of doctors = 12
- number of surgeries/doctor/day = 3
- operating rooms = 4
- operating room hours/day = 9
- available beds = 100
- average length of stay per patient = 3 days
- operating schedule for five days of surgery per week

In a “state” formulation, we define any operating state as:

[# doctors, # surgeries/doctor/day, # OR, OR hours/day, # beds, average length of stay, # days /week surgery is done];

Then, can be written as:

[12, 3, 4, 9, 100, 3, 5]

We take the performance measurement for our analysis as the weekly throughput, that is defined as average number of patients treated in a week. Attempts would be made to maximize this performance measurement, without sacrificing the quality of care.

At first, we observe some interesting results that would establish that the problem needs to be studied in greater detail.

Due to explain the current hospital capacity management issue in greater detail, let’s assign the following notations to the variables and resources:

Cb: Weekly capacity of beds; Co: Weekly capacity of operating rooms; Cd: Weekly capacity of doctors  
 co: Daily capacity of operating rooms; cb: Daily capacity of beds; cd: Daily capacity of doctors Then,  
 $Cb = p * cb$ ;  $Cd = p * cd$ ;  $Co = p * co$

where p is the number of days operated in a week

The lowest of the above three numbers will represent the bottleneck for the system, and system capacity for a week can be represented by,

$\text{Min} [Cb, Cd, Co]$

For the base case whose state was depicted earlier as [12, 3, 4, 9, 100, 3, 5], let us try to calculate the weekly capacity of whole system.

Weekly capacity of doctors =  $12 * 3 = 36/\text{day}$ ;  $36 * 5 = 180/\text{week}$

Weekly capacity of OR =  $4 * 9 = 36/\text{day}$ ;  $36 * 5 = 180/\text{week}$

Weekly capacity of beds =  $100 * 5 / 3 = 167/\text{week}$

Thus, the calculation of  $\text{Min} [180, 180, 167]$  will result in a weekly system capacity of 167 patients and beds will be marked as the bottleneck.

### **Calculating Capacity of Beds**

The calculation of weekly capacity of beds in this situation is not trivial. Consider that for a given 100 beds, five days a week surgery and an average patient stay of three days, in fact the calculation of  $100 * 5 / 3 = 167$  is not the correct method to determine the weekly capacity of the beds. Such calculation is true only if patients are admitted uniformly across the five days of the week. But obviously in reality, there is no



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need to impose that constraint to the patient admittance policy. Here comes the real bottle neck questions – Are the beds the true bottleneck? What's the true capacity of the beds?

To answer these questions, let us consider beds as an independent resource that is unaffected by other resources. We would like to maximize the weekly capacity (thereby throughput) of the beds. The only constraints will be: (1) daily available beds of 100, and (2) admittance of Saturday through Thursday, while there is no surgery during the weekend.

The simple programming maximization formulation can be written as:

$$[P1] \text{ Maximize } \sum_{n=Sat}^{Thu} X_n \quad (1)$$

Subject to,

$$\text{Daily beds occupied: } B_n = B_{n-1} + X_n - D_n \leq 100 \quad (2)$$

$$\text{No admittance: } X_{Fri} = 0 \quad (3)$$

$$\text{Daily discharges: } D_n = X_{n-3} \quad (4)$$

where, the decision variables are:

$X_n$  = patients admitted on a given day, with  $n$  = day of the week

$B_n$  = beds occupied on a given day, with  $n$  = day of the week

$D_n$  = patients discharged on a given day, with  $n$  = day of the week

Solving this simple programming formulation, we get interesting results. Optimal solution would admit 50 patients on Sunday, Monday and Wednesday and Thursday, and zero patient on Tuesday – for a weekly capacity of 200. Such weekly capacity of 200 patients is higher than the weekly capacity of doctor and operating room at 180 patients. Then should we report that the beds are not indeed the bottleneck?

Therein lies the central theme of this paper – how do we compare capacities of dissimilar resources? This question is further complicated in our above case since surgeries aren't performed during the weekend, but patients are allowed to recover through the weekend (for example those who were operated on Fridays, will arrive on Thursdays, stay through the weekend and be released on Saturday).

## Conclusion

Capacity management is among hospitals' key and important challenges. When hospitals do not successfully manage capacity assets, they will suffer by way of revenue loss, delays, operational inefficiency and patient dissatisfaction. Efficient capacity management only can be built upon a foundation of accurate forecasting and timely scheduling.

Healthcare industry has been investigating various strategies to manage capacity with a view to enhance efficiency and productivity, which can add value of the service provided.

Healthcare managers and executives are always searching for better ways to improve hospital operational efficiency and the subsequent value of care to patients. In any hospital, resources are generally limited. With regard to the limited resources, it is essential to find optimal way to admit patients in order to maximize efficiency and productivity, and then patient throughput.

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