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OB-GYN CONFIGURATION SIMULATOR: A PLANNING TOOL

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ABSTRACT

This paper presents a methodology developed for hospitals to increase and stabilize the occupancy in their Obstetric (OB) and Gynecology (GYN) Units. Since OB occupancy in many hospitals can vary significantly from day to day, an inefficient staff and bed utilization can result. The following technique provides a hospital with the capabilities of utilizing some of the OB beds for GYN patients while maintaining the risk of an unavailable bed for an OB patient to the minimum.

INTRODUCTION

The purpose of this paper is to show a methodology for determining the appropriate capacity of an Obstetric Nursing Unit within a combined Obstetric (OB) and Gynecology (GYN) configuration. Typically, OB units experience the chronic problem of low occupancy. In an effort to accommodate peak demands, most hospitals maintain a safety margin of empty beds which results in a low average census. The net result of a low occupancy rate is an inefficient operation, resulting in increased cost to the consumer. In an effort to increase the efficient utilization of the OB unit, many hospitals have now adopted the policy of admitting non-OB patients to the OB unit. There are several restrictions of this policy, such as the type of patient that can be admitted to the OB unit, the number of non-OB patients to be admitted to the unit, and the maximum occupancy level in OB under which non-OB patients can be admitted.

OBJECTIVES

The following are the objectives set forth for the study:

1) To determine the maximum occupancy that can be achieved within the OB unit.

2) To establish decision rules on when and how many GYN patients can be transferred to the OB unit.

3) To increase OB occupancy to a level at which Labor & Delivery gueues will not be increased over a given limit.

4) To decrease fluctuations in OB occupancy in order to increase the efficiency of staffing the unit.

5) To increase the bed availability on GYN which will result in effective increase of Medical/Surgical capacity to admit patients.

ALTERNATIVE TO BE EVALUATED

In addition to regular OB admissions, accept transfers from the GYN unit during periods of high OB availability such that:

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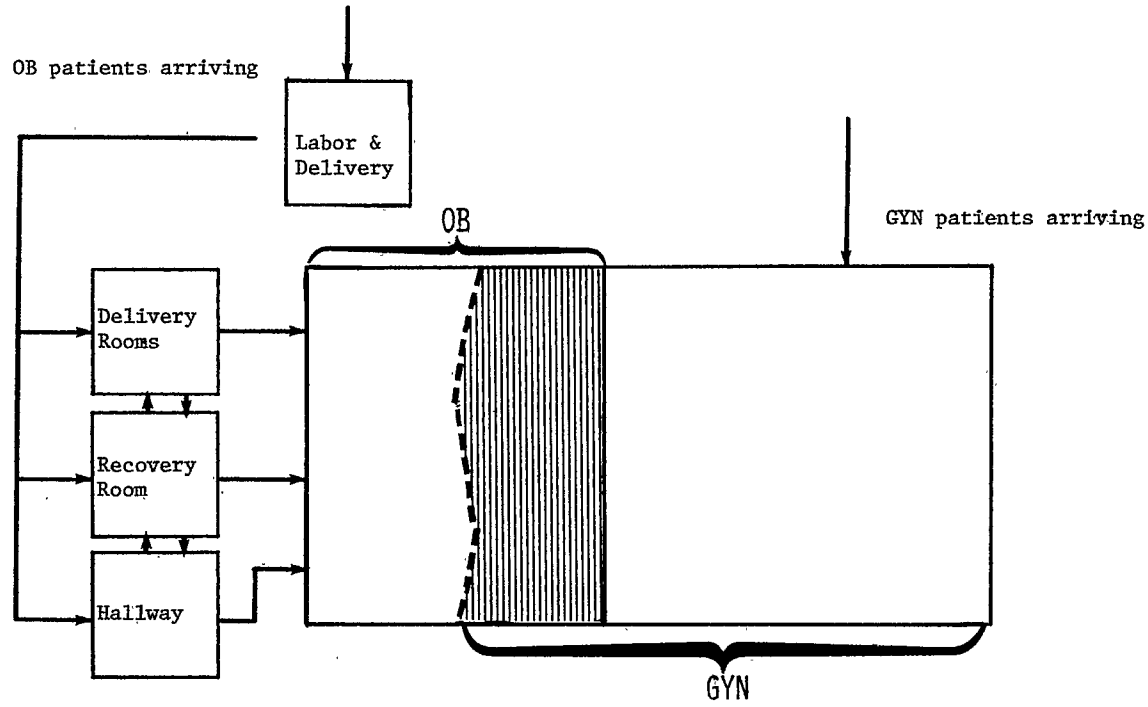
1) Admissions of GYN patients are regulated to maintain adequate bed availability without disrupting admissions to the OB unit.

2) The risk of forced discharge and/or long Labor & Delivery queues should be maintained within acceptable limits.

METHODOLOGY

In order to evaluate the proposed alternatives a simulation model of the Labor & Delivery - OB - GYN units was developed. The model was written in GPSS/V. Since the modeled system is basically a queueing system, GPSS is very suitable for this task. The basic system concept is shown in Fig. 1.

Fig. 1



The OB arrival stream was found to be of a random nature. Some seasonal effects were found, time of year; week of month, but within a "small" Δt where Δt is approximately one week, the OB arrivals were found to resemble a Poisson process. A chi square test was performed to verify this finding and this hypothesis could not be rejected. If we denote the arrival rate by $\omega(t)$ then

$$\omega(t) = \omega \cdot S(t) \cdot M(t)$$

where $S(t)$ - seasonal factor

$M(t)$ - week number within a month factor

$M(t)$ can be written as

$M(t) = m_{ij}$ for i = month 1, --- 12

j = week number 1, 2, 3, 4

$$\omega(t) = \omega \cdot S(t) \cdot m_{ij}$$

Then the average number of beds occupied (average census) can be computed as $AC = \omega(t) \circ LOS$ where LOS is the average Length of Stay of these patients. Note that the LOS is a Random Variable too. The average occupancy level (AOL) can then be computed as:

$$AOL = \frac{AC}{\text{number of available beds}} = \frac{\omega(t)\ LOS}{B}$$

It was found that for hospital units where the arrival rate is mainly random in nature the AOL would range between .70 to .75 with significant fluctuations in occupancy from day to day. The occupancy level can vary all the way from 0.5 to 1.0. At the same time the GYN-Medical and Surgical units have a significantly higher and stable occupancy rate since part of the arrival stream to those units is made of planned admissions. The basic idea of this study is to show a method by which we can increase and stabilize the OB occupancy rate without significantly increasing the risk of "over loading" the OB unit. (Overloading will occur when an OB patient needs a bed and there is not one available.)

BASIC ASSUMPTIONS

1) There is a "fall back" capacity for OB patients that need an OB bed when one is not available. The OB patient can stay for a period of less than 24 hours in Labor & Delivery or Recovery if they are not full. If full, the patient will be placed in the hallway for a limited amount of time.

2) When OB occupancy is below a specified level "K" we can transfer or admit a certain type of GYN patient to the OB unit. The number of patients to be transferred to the OB unit will be noted by "g".

3) Decisions to transfer patients from GYN to OB cannot be done on a continuous basis but at defined times of day.

Now we can formulate the problem as:

Find:

K - the OB occupancy level below which we can transfer GYN patients into OB

g - number of GYN patients to be transferred at that time

Such that:

$E[OL] \geq r$ r - a given occupancy level

and

$$\text{Min} \left\{ f\,[\omega(t),\ LOS_{ob}\ LOS_{gyn},\ k,\ g] \right\}$$

Where OL is a function of $\omega(t)$, LOS, k, g.

THE COMPUTER MODEL

The GPSS model generates both OB and GYN patients. The OB patients (transactions) flow through the different steps in the Labor & Delivery - Recovery complex. At fixed times during the simulated day, the computer will check the status of the system and will decide how many GYN patients can be moved. Statistics on the frequency of "overloading" are being collected as well as the utilization of the various system components. The following is a list of the variables used in the system.

POLICY VARIABLES

1) The size and nature of the GYN population that can be admitted to OB.

2) The maximum wait for a post partum patient before an OB bed is available.

3) The maximum Labor & Delivery capacity for post partum patients.

4) The minimum number of beds that must be kept available for OB admissions. (OBMIN)

5) The maximum number of GYN admissions to OB that can be made each day. (GYNMAX)

OUTPUT VARIABLES

1) Daily occupancy of OB. 2) Daily distributions of waiting times in Labor & Delivery. 3) Daily distribution of number of Labor & Delivery patients waiting for an OB bed.

FACILITY CAPACITIES

Labor Rooms.....7

Delivery Rooms.....2

Operating Rooms.....1

Recovery Rooms.....4

Queue Capacity.....Unlimited (an assumption)

OB Beds.....28

GYN Beds.....34

ANALYSIS

The Labor & Delivery - OB - GYN units were simulated for six (6) months at a time. A selective summary of the simulation runs is shown in Table 1. During each simulation run, a decision was made at 1300 hours whether or not to transfer GYN patients to OB and if yes, how many. This decision was based on two values. The OBMIN (minimum number of beds to be left in OB for the next 24 hour admissions) and they GYNMAX (maximum number of GYN patients that can be transferred from GYN to OB in one day). The following decision rule was used: at 1300 hours the number of empty beds in OB was computed and designated as X.

If X is greater than OBMIN then:

$$\text{Transfer Min} \left\{ \text{X-OBMIN} \;;\text{GYNMAX} \right\} \text{ patients}$$

In other words, transfer (X-OBMIN) or (GYNMAX) patients whichever is smaller

Table 1 shows the effect of these transfer policies on the OB occupancy and the Labor & Delivery patient waiting for OB beds. The above algorithm was selected because decisions on patient transfers are usually made in a hospital by the Admitting Department, and therefore clear and simple rules will ensure a smooth operation of such a system. For example, it is very easy to determine the number of empty beds in a specific unit much more so than to try to compute the occupancy. During the analysis, four decision parameters had been varied. They are:

1) OBMIN

2) GYNMAX

3) Time of day the decision is made

4) Arrival rate of OB patients.

The role of OBMIN is to maintain a minimum number of beds available for OB patients. GYNMAX's role is to prevent the excessive load-up of the OB unit during a low occupancy occurrence. The arrival rate was varied in order to analyze the sensitivity of the system to small changes in ω, with the idea that with each $\forall t$ ω is constant.

TABLE I

ARRIVAL RATE 5.42 PTS/DAY

DECISION AT 13:00

OBMIN** \ GYNMAX*	0	2	4	6	8	10	28
0							A=.919 B=7 C=18.41 D=4.69
2				A=.863 B=5 C=16.48 D=3.07	A=.866 B=5 C=16.48 D=3.07	A=8.67 B=5 C=16.48 D=3.07	
4		A=.746 B=2 C=14.02 D=2.52		A=.813 B=2 C=17.64 D=2.42			
6				A=.768 B=2 C=16.71 D=2.42			
28	A=.613 B=1 C=11.98 D=2.35						

* GYNMAX Maximum number of patients that can be transferred from GYN to OB in one day.

** OBMIN Minimum number of beds to be left in OB for the next 24 hours admissions.

A=OB occupancy
B=Max pts in queue at one time
C=Avg LOS in queue
D=Avg LOS in Recovery Rm (normal & C-sect.) in hours.

FINDINGS

From the results obtained in this study, it appears that a great improvement of hospital resources utilization can be achieved by transferring GYN patients to OB during low OB census. Not only will the unit utilization increase from the present 60% to over 80% but at the same time the occupancy level variance will be drastically reduced, allowing for more efficient staffing utilization. It was found also that just from the transfer policies we in effect were able to increase the actual Medical/Surgical

capacity by five (5) beds, which provide a revenue increase of $254,000.00 a year. The described system was implemented at the hospital in February 1979 with great success.

CONCLUSIONS

Admissions to Labor & Delivery and OB units were found to be of a random nature (Poisson) as well as the Length of Stay (some empirical distribution). Because the admission process is random, it was difficult to predict the number of post partum beds required to meet demands which fluctuate. In the past it has been the customary practice of most hospitals to provide enough post partum beds to meet peak demands. Inefficient utilization increased the costs to consumers and a low average occupancy rate may be viewed as having a direct relationship to unit sizing (number of beds) based on maximum demands. By providing the hospital with easy to use decision criterion on the number of GYN patients, the type of patient and, how many and when to transfer them to OB can significantly increase the utilization of resources in the hospital with little or no cost increases and by doing so reduce the overall cost to the patient.

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