Flexible Nursing Staff Planning When Patient Demands Are Uncertain

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Determination of appropriate nursing staff levels to provide quality service and maintain economic efficiency is a difficult problem for health care administrators to solve. The objective of this paper then is to present a mathematical model for determining the number of staff among full time and part time staff as well as overtime when patient demands are uncertain. The demand level is considered as a distribution on a daily basis. The model intends to integrate an entire week as a whole so that the number of staff is found on a weekly basis. Based on this model, the nursing workforce can accommodate patient needs efficiently and economically while remaining flexible in an uncertain demand environment.

INTRODUCTION

The health industry faces several problems such as long patient waiting periods, high mis-diagnoses, nursing shortage and financial losses which raise the cost of health care and reduce a provider's competitive edge. The key to successful competition lies in the concept of quality improvement and cost reduction. Among operational costs, nursing is the largest single category in most hospital budgets. Hence, determination of appropriate nursing staff levels to provide service and maintain economic efficiency is a difficult problem for health care administrators to solve.

In manufacturing, the product is a tangible good and because this good is physical in nature, it can be stored and transported. In the service sector, the product is intangible in nature and can be viewed as a transitory product which cannot be stored as inventory for future use. Thus, the delivery of services presents a special problem for inventory and capacity planning, since it is impossible to offer a service ahead of time and the inventory option does not exist. Simply stated, services can be defined as something which are produced and consumed more or less simultaneously. Another problem is the variation in service demand level. The reasons for this stem from the uncertainty of types and requirements of future demands. Additionally, the frequency of occurrence for particular jobs is unknown and unpredictable. As a result, service producers differ from manufac-
turing producers in important aspects of their operations. Therefore, service demand should be considered variable under some distribution instead of being a deterministic value. These points have been pointed by Flagles as well. Furthermore, flexible staffing operations for quality service are necessary in order to accommodate uncertain patient demands.

Due to the nature of service provision, capacity needs to be expanded in advance of demand. However, the demand does not materialize, the increased capacity is wasted and higher costs result. On the other hand, we cannot use current capacity to produce an inventory of goods for consumption in future periods. Hence, the mathematical staff model to be developed must be highly flexible and dynamic in accommodating the uncertain nature of service demand.

The nurse staffing problem has been considered as having three decision levels in a planning and scheduling model formulated for the nurse staffing process. They are policy decisions, staff planning, and scheduling; the latter based on given constraints from the first two. Due to the variable nature of nursing demands as discussed above, we will consider nursing demands to be approximated as a normal distribution in staff planning and budgeting. To date, few previous staff planning models have considered nursing demands as a variable. For instance, Kao and Queyranne formulated the problem as a two stage stochastic program to obtain the minimum expected cost. The implicit assumption in these models is that the full time staff is constant over a budget cycle. Shortages in the necessary workforce are considered to be met by part time staff and overtime. The full time workforce is found in first stage while the part time workforce and overtime are found in the second stage. The fundamental premise in these models is that the full time staff is constant over a budget cycle. This paper is divided into four sections, beginning with the introduction. Section two is the model developed. Section three presents a discussion and one example. Then, a summary is given in the final section.

MODEL DEVELOPMENT

A nursing staff is usually categorized into full time and part time with overtime being on an as needed basis. Full-time staff is a fixed staff whose members work a few given days in week. For example, one full-time staff member is allowed to work on Monday through Friday, while another staff member works Tuesday through Saturday, etc. Ba-