



Improving scheduling of emergency physicians using data mining analysis

C.C. Yang^a, W.T. Lin^b, H.M. Chen^{a,c,*}, Y.H. Shi^a

^a Department of Industrial Engineering, Chung-Yuan Christian University, Taiwan

^b Department of Industrial Engineering and Management, National Chin-Yi University of Technology, Taiwan

^c Office of Medical Information Management, National Taiwan University Hospital, No. 7, Chung San South Road, Taipei 100, Taiwan

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ABSTRACT

Emergency departments are the first line in hospitals to face emergency patients. As a major function of emergency medicine, when a patient comes to the emergency department, the emergency medical personnel will first perform a triage procedure and then transfer the patient to associated departments for treatment. Due to the utilization pattern of the Taiwanese people in medicine, the emergency departments in most major hospitals are always overcrowded. The arrangement of manpower or the distribution of resources to handle patients' demands can affect disease outcomes and quality of medical treatment. Therefore, the prediction of demands of physician manpower certainly will affect the quality and cost in medical treatment, and has significant impact on patients' life and satisfaction. This study used data mining, classification and a decision tree to analyze the prediction model of patients' demand in the Emergency department from real treatment situations. The result was the accuracy of shift anticipation improved from 22% to 50%. This study also used anticipant performance evaluation matrix integrated with loss function to evaluate the performance between the anticipation of demand established by mining and the original arrangement. It helped to save the cost of the medical personnel by 37%. In the end it combined the DMAIC action procedure from 6-Sigma and developed an anticipation model that can be suitable in different departments to dispatch medical personnel. It provided a reference of the decision maker of the hospital.

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1. Introduction

Along with the development of the Internet and the maturation of database techniques, the methods of data and information storage in different businesses and professions have become more diverse and simpler today. In order to combine the applications of the Internet, many people are promoting data digitalization. Large quantity data collection techniques, high performance multi-processor computer structure and the maturation of data mining mathematical algorithms are the three most important elements for the prosperous development of data mining today. They have been extensively used in different business and professions (Kdnuggets, 2007). Generally medical institutes only use general statistics skill instead of data mining techniques to properly utilize this information. We need to think how to collect useful information from this enormous database and find valued knowledge for medical or hospital management; how to utilize this information effectively to improve the efficiency of management, quality and costs in the hospital; understand patients' demand for medical

treatment and make a proper medical service strategy. But in fact, most of hospitals are not doing this at present.

Currently the dispatch of emergency manpower is always made by each department from experiences and emergency triage. However, patients' sickness distribution and variation in the patient numbers in peak and non-peak hours are not fully considered, so the emergency department might do jobs in a hasty and disorderly manner or might be over-crowded. While emergency medical procedures are heavy and complicated and emergency departments are always filled with patients, how can we establish a medical manpower deployment system to enhance medical quality and reduce medical disputes? (Academia Sinica, 1998; Yang & Yang, 2004) The main purpose of manpower resources planning is to reduce uncertainties. By clarifying the environmental uncertainties and planning before it happens, we expect to reduce the impact (Dessler, 2006; Richard, 1988). If medical manpower can be appropriately deployed, hospitals not only can provide medical care that is cost effective and also satisfying to the patient (Chou, 2003; LaMar, Jacoby, Meyer, & Potter, 1997; Yeh, Wang, Chen, & Li, 2003).

In the past most studies in physicians' shift arrangement emphasized outpatient physicians' shift arrangement (Liu & Wang, 2005); however characteristics of the demand on emergency physicians are a little bit different. There are two major differences between emergency services and outpatient services. The first is

* Corresponding author. Address: Office of Medical Information Management, National Taiwan University Hospital, No. 7, Chung San South Road, Taipei 100, Taiwan. Tel.: +886 2 2356 2904; fax: +886 2 2341 0239.

E-mail addresses: admchmz@ntuh.gov.tw, admchmz@ntu.edu.tw (H.M. Chen).

the urgency of physicians' diagnosis. Generally patients in the emergency departments need urgent treatment in a very short time. Therefore, emergency departments have a triage system in accordance with patients' condition (Tsan, 2006). The second major difference is that the emergency service is provided 24 h a day, while the outpatient physicians have demand-led shifts.

In this research, hospitals divide outpatients into 6 departments, including internal medicine, surgery, traumatology, pediatrics, obstetrics and gynecology and dental departments. The rule of department assignment does not depend on patient numbers but because of the hospital's policy and the payment system of the National Health Insurance. Also because of hospital organizational structure and demands from medical education, emergency physicians do not take all the shifts in the emergency department; generally the above mentioned six departments assign a resident physician to perform the first line services in the emergency department each month. Therefore, the emergency department is like an epitome of a small hospital. The study takes the largest department in the emergency department, the internal medicine department, as the research object and makes some suggestions to improve the arrangement of the physicians' shift schedule.

In this research, the objective of human resources utilization is that the numbers of physicians should be considered by patients' requirement in order to promote the quality of emergency service and arrange proper number of personnel. It compares current internal medicine physicians' shift arrangement in the emergency department and selects the variable. In the emergency medicine of the case hospital, demand of the patients' side is to triage and provide emergency treatment to the patient in the first place. On the supply side it should include the allocation of personnel from different fields such as physicians, nursing staff, technicians, social workers, first aid technicians, administrative staff, janitors and vol-

unteers. This study focuses on direct manpower supply of emergency physicians; accredited physicians from other departments and other indirect personnel are not considered.

To conclude from the above, according to actual demands for physicians, it is planned to use triage technique as a preliminary analysis tool to analyze the emergency patient inspection and shift arrangement data. After developing a forecast model, a performance evaluation matrix combining Taguchi's Loss Function is the final performance evaluation method. This procedure is also used to build a 6-Sigma's DMAIC action procedure (George, Rowlands, Price, & Maxey, 2005) to achieve a continuing improvement administrative circulation for future references, shown in Fig. 1.

2. Definition of the forecast performance evaluation matrix and control line

2.1. Definition of the forecasted performance evaluation matrix index

The performance evaluation matrix in the past took the Performance Evaluation Matrix that was mentioned by Lambert and Sharma (1990) as a reference for performance improvement strategy. Lin, Chen, and Chen (2005), however, modified the concept of Lambert and Sharma's Performance Evaluation Matrix. First we used the matrix composed by the level of important simple as an example explanation. According to the concept, the index of importance level is the vertical coordinate and the index of simple level is the horizontal coordinate. The range of both index values is between 0 and 1. In this study, it is modified by the moderate performance evaluation matrix. The forecast value is the vertical coordinate and the real value is the horizontal coordinate. The new area is re-defined as shown in Fig. 2, which follows.

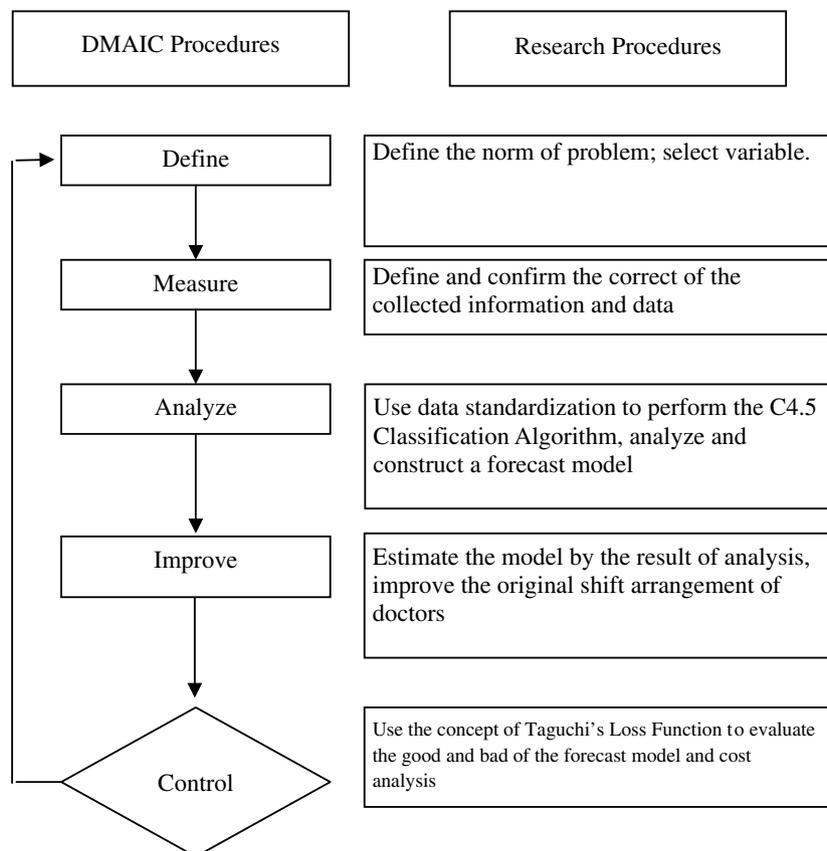


Fig. 1. The DMAIC research procedure.

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