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Technical Efficiency of Nursing Units in A Tertiary Care Hospital in Taiwan

Thomas T. H. Wan,1 4 Nanly Hsu,2 Rung-chuang Feng,2 Alien Ma,1 Shuang-an Pan,3 and Mei-chi Chou2

The variation m productivity and cost efficiency has been observed among ^7 nursing units in a large tertiary care hospital. The inefficient units can achieve the same level of efficiency as the efficient units by altering their inputs (either nursing hours or patient costs) The optimization can be achieved through proper reallocations of nursing resources such as nursing hours or costs. However, the 70Mrce/efl//o^on;o^^^^ high efficiency should not be at the expense of quality of care. Future efficiency studies should incorporate the nursing sensitive measures of quality in the analysis._____

KEY WORDS: technological efficiency; nursing; productivity.

INTRODUCTION

Nursing productivity and patient care cost are two important components of hospital management. It is necessary for hospital administrators to identify the level of nursing units' performance associated with nursing productivity and efficiency in patient care. Information pertaining to the performance variation and sources of the variation is germane to make administrative and managerial decisions in allocating critical resources. This study's focus is to explore the technical efficiency of nursing productivity and patient care costs among 57 nursing units, in a tertiary care medical center, using the data envelopment analysis (DEA) technique. This analytic technique identifies efficient and inefficient practices among nursing care units and provides an understanding of improved managerial decisions that decrease the enormous cost related to resource utilization.

The primary research question in this study is: Do nursing units differ significantly in their productivity and utilization of nursing resources at a tertiary care hospital?

[1] Department of Health Administration, Virginia Commonwealth Un.versky Ru-hmond, Virginia 23298.
[2] Department of Nursing. Veterans General Hospital-Taipe., Taiwan. Repubhc of China.
[3] DepartS of Information Service Center. Veterans General Hospital-Taipei. Taiwan, Republic of China.
[4] To whom correspondence should be addressed.

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RELATED RESEARCH

Previous nursing research on productivity is relatively focused on the team approach,0) management functions^2-^ reengineering/"0 handover process/-^ staffing patterns/6"1^ effective use of staff time.(1()) competency-based staff development,(11) and use of an automated nursing discharge summary0^ and other electronic monitoring/scheduling systems.03-14) To date, little is known about how reallocation of nursing resources may effectively improve the productivity of nursing staff.

Nurse staffing patterns have come under increased scrutiny as hospital executives explore the cost-cutting opportunities in managing resources. In evaluating relative efficiencies of Veterans Affairs Medical Centers, Hao and Pegels0^ reported that about half of the study hospitals were relatively inefficient. However, nurse staffing was not considered to be a predictor variable of hospital inefficiency. In a study of nurse output, Eastaugh0^ reported that productivity varied widely among hospitals as a function of staffing patterns and the degree of reliance on nurse extender technicians. This study suggests that the use of nurse extenders can free RNs from the burden of performing nonnursing care activities.

In summary, research on the variation in nursing productivity and efficiency is needed. This study will shed some light on the redesign of strategies for improving staff efficiency in an increasing competitive hospital market in Taiwan, resultant from the implementation of the universal health insurance program.

METHODOLOGY

Data Envelopment Analysis (DEA)

DEA, a procedure designed specifically to measure relative efficiency in situations where there are multiple inputs and outputs,07* is a linear programming-based methodology. It is a nonparametric approach used to measure the relative productive efficiency, or productivity, of each member among a set of comparable producing units. In DEA, the unit of analysis is called decision-making unit (DMU).0-^ In health care applications, a DMU may be defined as narrowly as an individual nursing unit or as broadly as a hospital.

Through linear programming calculations, the DEA method draws a production possibilities curve, or data envelope, from combinations of unit inputs and outputs. This curve is also called efficient frontier. The DMUs located on the frontier are technically efficient and have an efficient score of 1. DMUs away from the efficient frontier will have a score between 0 and 1, making these DMUs inefficient. Therefore, in DEA, the efficiency of a DMU is defined in terms of its position relative to the efficient frontier.0^ly)

In DEA. the relative efficiency of an organization, agency, or nursing unit is defined as the ratio of its total weighted output to its total weighted input. A DEA computing program enables the determination of inputs and/or outputs appearing to be inefficiently used or produced by DMUs.

Data

This study's data were compiled for a 3-month period (July. August, and Septem->er) in 2000. The management reports of the 3000-bed hospital's Nursing Department vere used to generate^monthly data. The DMUs consist of 57 nursing units that are taffed by 100 of the registered nurses.

Model Specification

The variable return to scale (VRS) model was used. It assumed that the relation-,hip between outputs and inputs varies and therefore is not a linear relationship. In he VRS model, changes in inputs resulted in varying degrees of changes in outputs.

Input Orientation

The input orientation assumed that nursing units have little control over outputs, ^hich. in this case, refers to the number of patients. It is more appropriate to direct discussion regarding inputs to units having control over utilization of resources for patients or nursing^hours). Thus, an input-oriented DEA model was used for the analysis.

Variables

This study evaluated a total of 11 variables: 7 input and 4 output variables. An in-patient classification system was used to identify the acuity of patients. There were four classes of patients: Class I (lowest severity level, needing nursing care less than 2.18 h per patient per day). Class II (2.18-3.07 h). Class III (3.08-4.35 h), and Class IV (highest severity level, needing nursing care more than 4.36 h per patient per day). The seven input variables for each individual nursing unit were 1) nursing hours for the day shift, 2) nursing hours for the evening shift, 3) nursing hours for the night shift, 4) costs for caring for Class I patients, 5) costs for caring for Class II patients, 6) costs for caring for Class III patients, and 7) costs for caring for Class IV patients. Four output variables were: 1) number of Class I patients, 2) number of Class II patients, 3) number of Class III patients, and 4) number of Class IV patients. Two different models were analyzed based on different inputs employed while maintaining the four constant outputs: 1) nursing-hours model and 2) patient-costs model.

For both models analyzed, the outputs included the number of patients classified into four groups. The nursing-hours model included three input variables: day-shift, evening-shift, and night-shift nursing hours. The patient-costs model has four patient variables: Class I, Class II, Class III. and Class IV patient costs.

RESULTS

The descriptive statistics for the performance of all 57 nursing units (i.e., DMUs) are shown in Table I. The medical center treated more Class I patients

Table 1. Descriptive Statistics (N = 57)

Variables	Mean	SD
Output (number)		
Class 1 patients	1872	726.23
Class 2 patients	759	275.23
Class 3 patients	"11	259.89
Class 4 patients	277	256.26
Input		
Day shift nursing hours	3533.90	815.26
Evening shift nursing hours	1885.26	376.91
Night shifting nursing hours	1509.47	255.51
Class 1 patient costs (NTS)	1402098.14	536104.13
Class 2 patient costs (NTS)	1169268.56	430476.13
Class 3 patient costs (NTS)	1136777.84	568138.26
Class 4 patient costs (NTS)	898109.87	824674.84
Average patient cost per unit		
Class 1 patient costs (NTS)	748.90	—
Class 2 patient costs (NTS)	1539.93	—
Class 3 patient costs (NTS)	2222.93	—
Class 4 patient costs (NTS)	3241.86	

Note. Values that were not computed because the cost was based on per patient per nursing unit are indicated by dashes.

(average N=1,872 per nursing unit) than other classes of patients. In the provision of nursing care, the unit spent an average of 3533.90 h for a day shift, 1885.26 h for an evening shift, and 1509.47 h for a night shift. For each nursing unit, the cost of caring for each patient was different in terms of different patient classification. Each unit spent an average of NT$3241.86 for caring a Class IV patient and NT$748.90 for a Class I patient.

DEA Analysis

Nursing-Hours Model

Table II displays the efficiency results of 57 nursing units. For the nursing-hours model, 28 units (49.12) were efficient and 29 units were inefficient. The average efficiency score of all units was 0.96. with a standard deviation of 0.06. Excluding the efficient units, the average efficient score of inefficient units was 0.91, and the standard deviation was 0.06.

Table 11. Efficiency Analysis Results in Nursing Units (Nursing-Hours Model)

Variables	/V	Mean	SD
Number of efficient units	28	49.12	
Number of inefficient units	29	50.88	
Efficiency			
Efficient units included	57	.96	.06
Efficient units excluded	29	.91	.06
Total inefficiency			
Dav-shifl nursing hours	29	507.79"	294.12
Evening-shift nursing hours	29	234.38"	142.50
Niyhl-shifl nursing hours	29	151.87"	107.23

[a]Mean of the total hours of the inefficient units.

In analyzing the efficient units, the total inefficiency score for each unit was computed. TotaF inefficiency refers to the difference between the measured value and the projected value for each input and output. Efficient units always have an equal measured value and the projected value for both input and output (total inefficiency = 0). Inefficient units often have the measured input value higher than the projected value. The results of input total inefficiency suggest that inefficient units need to reduce the resource utilization in an amount of 507.79 nursing hours for the day shift. 234.38 h for the evening shift, and 151.87 h for the night shift.

Patient-Costs Model

The analysis of 57 nursing units shows there is cost variation in nursing care. In the patient-costs model, 30 (52.63) of the 57 units were efficient. The remaining units, 27(47.37), were classified as inefficient compared to efficient nursing units (Table III). Furthermore, inefficient nursing units spent more resources than efficient units: an average of NT$ 194.660.21 for Class I patients, additional NT$88,973.66 for Class II patients, over NT$84.398.69 for Class III patients, and more than NT$51.743.24 for Class IV patients as compared to the efficient umts.

To identify the unit that needs to be optimized for its performance, the detailed analysis of slack for each inefficient unit should be conducted. An output slack indicates that for a given set of inputs a DMU has failed to produce the expected output level relative to the DMU's peers on the efficiency frontier. Similarly, an input slack means that a DMU used an excessive amount of input to produce a given level of output relative to its efficient peers. For example. Nursing Unit 40 was identified as an inefficient unit according to patient-costs model, and its efficient score was 0.88. A detailed analysis of slack found that Unit 40 had two input slacks—Class I patient cost slack (NT$237,345.37) and Class III patient cost slack (NT$2,147.69). The other two inputs (Class II and Class IV patient costs) had no slack (slack = 0). In order to reach a higher level of efficiency. Unit 40 needs to reduce the cost of care in a total amount ofNT$237,345.37 in Class I patient care and NT$2,147.69 in Class III patient care.

Table III. Efficiency Analysis Results in Nursing Units (Patient-Costs Model)

Variables	N	Mean	SD
Number of efficient units	30	52.63	
Number of inefficient units	27	47.37	
Efficiency			
Efficient units included	57	.97	.04
Efficient units excluded	27	.94	.04
Total inefficiency			
Class 1 patient costs	27	194660.00"	174040.09
Class 2 patient costs	27	88973.66"	55096.17
Class 3 patient costs	27	84398.69"	55684.04
Class 4 patient costs	27	51743.24"	47367.19

" Mean of the total costs of the inefficient units (NTS).

CONCLUSION

DEA has been applied to the analysis of technical efficiency of 57 nursing units in terms of nursing hours and patient care costs. Twenty-seven units were identified as highly efficient in nursing hours scheduled, and 30 units were identified as highly efficient in patient care costs.

The variation in productivity and cost efficiency has been observed among 57 units. The inefficient units can achieve the same level of efficiency as the efficient units by altering their inputs (either to reduce nursing hours or patient costs). The optimization can be achieved through proper allocations of nursing resources such as nursing hours or costs. However, this critical decision has to be made in conjunction with maintaining a reasonable level of quality in patient care. In other words, the resource reallocation to achieve high efficiency should not be at the risk of lowering the quality of care. Future studies should incorporate nursing sensitive measures of quality in the analysis. Thus. the balance between efficiency and quality can be effectively attained.

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