
The Panel Study of the Effects of Medical Education in Primary Settings

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Almost all cost-benefit analyses of medical student training programs have been conducted among those working in the inpatient settings such as teaching hospitals or general hospitals. Few studies, however, have examined the role of medical student training in primary health care center until recently. This study deals with the effects of medical student training programs on the cost and personnels' productivity of primary care in health centers. Moreover, an attempt is made to identify and quantify the key components of such programs through a multivariate analysis of panel data.

The study results reveal that inner city health centers with medical student training programs show greater increase in the size/volume of total patient encounters, all personnel, and total cost and total revenue than health centers without such programs. Also, when physicians productivity is measured by the ratio of medical encounters per physician, the productivity is found to be statistically insignificant. Furthermore, the result shows that the productivities and unit costs can be adjusted by changing various structural input variables.

© Key Words : Health Centers Activities, Inner City,
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I . Introduction

Numerous studies of medical student training programs have been conducted among those working in the inpatient settings such as teaching hospitals or general hospitals which emphasizes the training of specialists (Busby, et al. 1972; Freymann and Springer, 1973; Sloan, et al. 1983; Cameron, 1985). In discussing the cost of medical student training programs, only the gross outlays of stipends and house staff maintenance are usually considered. The value of the services rendered by interns and residents are not recorded and are often ignored. Like the teaching assistants in colleges and universities, the interns/residents are often regarded as the source of inexpensive labor, working long hours in hospitals during the nights or weekends, and providing mainly for the acute and/or emergency care.

Recently, however, an increasing number of medical student training programs are being conducted in ambulatory settings. The shift in medical student training from inpatient settings to ambulatory settings and the shift from secondary and tertiary care to primary care have changed the focus of the study mainly on medical student training in outpatient facilities (Barnett, et al., 1989; Lave, 1989; Eisenberg, 1990; Garg, et al. 1991).

One of the central questions that motivated this study was that few studies have examined the role of medical student training in the primary care of health centers until recently.

Therefore, this study aims to examine the role of medical student training in the primary care of health centers whose clientele are mostly low-income population group and where physicians are

employed on a salary basis mostly financed by the government. For this purpose, the effects of medical student training programs on the cost and productivity of health centers are examined. The cost effects are estimated by comparing the differences in unit costs between health centers with and without medical student training programs. The unit cost is measured by the cost per patient encounter for each category. Determining the size of the effect of medical student training programs on the health center's cost per patient encounter would provide important information on deciding how costs ought to be allocated. The effects on productivity are estimated by a similar comparative analysis of the differences over time in the productivity of physicians and all other staffs employed by each center.

The secondary objective of the study is to search for and analyze the process of how medical student training programs influence unit costs and personnels' productivity of health centers. Finally, hypothesized factors that affect health center costs were chosen from past hospital studies. With these factors, a multivariate analysis was conducted.

II. Analytical Framework

An organizational and behavioral model of health centers must be formulated to examine the effect of medical student training programs on cost and productivity of health centers. It can be examined only within the framework of structural relationships existing in the operation of health centers. Although there are significant differences between the behavioral pattern of health centers and that of business

firms, an organizational/behavioral model of health centers may be built and modeled after the decision model of business firms. According to the theory of the firm, an organizational/behavioral model of business firms may be built in two ways: first, in terms of production function, profit function, and conditions of marginal productivity; and second, in terms of cost function, profit function, and conditions of marginal cost.

Although health centers are non-profit organizations, health centers cannot operate with deficit on a sustainable basis. Hence, as an organization dedicated to providing ambulatory care to a selective group of population, health centers need to operate as though they are business firms in some respect. In addition to quality of care, health centers have to minimize the cost for providing such care while striving to maximize productivity.

Therefore, the effect of medical student training programs on the cost and productivity has to be analyzed within the context of the behavioral model of business firms. In other words, the effect needs to be examined in terms of how such programs influence key variables in the existing cost function, production function and profit (revenue) function of health centers.

In terms of economic theory, the net effects of resident or medical student program on the physician productivity are positive if the patient care provided by the residents is a "complementary good" vis-a-vis that provided by the physicians themselves. If the patient care provided by residents is substitute goods for that provided by physicians, the net effects would be negative.

In this study, no attempt is made to formulate any formal cost, production or profit (revenue) function. Instead, the existing structural

relationships which determine the above functions are analyzed to find out how medical student training programs affect the cost and productivity of health centers.

III. Data and Methods

1. Data Sources

The primary data source for the study are from those reported in the Bureau of Common Reporting Requirements for 1990 through 1994 for six health centers of Cincinnati Health Network. In addition, the second source of information on how medical student training programs are conducted is obtained by interviewing medical directors responsible for the operation of the program. This information is used in the descriptive analyses of such programs. Two kinds of data are merged to estimate the effects of medical student training programs in health centers.

The list of variables selected from the data for analyses and the description of these variables are presented in Table 1. As listed, the selected variables are categorized by seven groups which are unit cost, productivity measured by the number of patient encounters, size-volume, service structure represented by the number of patient encounters, manpower structure, cost structure and revenue structure measured by its sources. Each category is also divided into several ratio variables except the category of size-volume.

Table 1. List Variables of Used in the Analysis of the Impacts of
Medical Student Training Program in Health Centers, 1990~
1994

Τηλε Πανελ Στυδσ οφ τηε Εφφεχτσ οφ Μεδιχαλ Εδυχατιον ιν Πριμαρψ Σετινγσ

Variables	year	Means(Std. dev.), Frequency and Measurement		
		health centers with medical student train- ing programs	health centers without medical student training programs	measurement / indices
Medical student training programs	90	2	4	dummy 1=yes, 0=no (no. of center)
	91	2	4	
	92	2	4	
	93	2	4	
	94	2	4	
Unit cost				
• Health services cost / number of health services encounters	90	1700.7(207.6)	1767.6(505.7)	dollars (\$)
	91	1803.2(596.2)	1767.6(505.7)	
	92	2172.1(958.8)	1869.6(468.2)	
	93	1723.7(231.7)	1752.1(576.1)	
	94	1575.0(121.3)	1747.7(344.1)	
• Medical cost / number of medical encounters	90	38.4(3.7)	32.2(4.3)	dollars (\$)
	91	35.8(4.5)	39.8(11.6)	
	92	42.3(1.8)	41.4(6.9)	
	93	44.1(3.2)	40.7(3.4)	
	94	50.3(5.4)	44.3(1.7)	
• Other health cost / number of other health services encounters	90	8.0(1.5)	12.9(8.9)	dollars (\$)
	91	8.3(0.4)	8.6(4.3)	
	92	8.7(1.8)	18.8(19.6)	
	93	11.7(3.3)	11.5(5.7)	
	94	12.8(5.2)	15.5(6.8)	
• Overhead cost / number of total encounters	90	9.9(4.3)	9.6(4.1)	dollars (\$)
	91	11.4(3.4)	9.9(4.9)	
	92	12.4(3.4)	10.9(5.2)	
	93	13.5(5.2)	16.2(5.6)	
	94	15.0(2.8)	18.8(7.7)	
Productivity				
• Number of medical encounters / number of medical personnels	90	1347.8(138.7)	1994.9(628.4)	no. of encounters (output)
	91	1504.3(306.2)	1944.1(560.9)	
	92	1482.0(301.6)	1794.7(688.6)	
	93	1299.7(91.4)	2040.1(317.8)	
	94	1373.5(294.0)	1862.3(340.5)	
• Number of health services encounters / number of health services personnels	90	30.5(4.5)	30.0(3.6)	no. of encounters (output)
	91	30.2(9.1)	31.6(6.9)	
	92	33.5(4.5)	39.1(13.8)	
	93	35.8(4.9)	37.0(4.2)	
	94	41.6(4.1)	43.3(6.6)	
• Number of other health services encounters / number of other health services personnels	90	5556.3(120.1)	4094.9(3511.4)	no. of encounters (output)
	91	5487.9(614.6)	3955.4(3146.9)	
	92	11240(10697.0)	2982.8(1077.1)	
	93	5649.4(240.1)	4513.1(4695.5)	
	94	3596.2(1696.0)	2424.3(1115.1)	

Table 1. Continued

ζαριαβλες	Μεανς(Στδ. δεσ.), Φρεθνευγυ ανδ Μεασυρεμεντ			
	νεαρ ηεαλτη οιτη μεδιγαλ ςτυδενη τραιν- ινγ προγραμς	ηεαλτη χεντερς οιτη μεδιγαλ ςτυδενη τραιν- ινγ προγραμς	ηεαλτη χεντερς οιτη μεδιγαλ ςτυδενη τραιν- ινγ προγραμς	μεασυρεμεντ/ ινδιχες
Σιζε-πολυμε				
• Τοταλ ενχουντερς	90	27452 (13067.0)	30419 (15184)	νο. οφ ενχουντερς (ουτπυτ)
	91	31912 (19808.0)	31462 (15336)	
	92	33011 (21392.0)	29741 (16420)	
	93	36424 (27444.0)	26146 (12879)	
	94	36921 (28415.0)	23714 (12144)	
• Αλλ περςοννελς	90	17.3 (3.3)	23.1 (5.8)	περςονς
	91	21.3 (7.7)	20.9 (5.8)	
	92	17.9 (4.8)	20.8 (7.8)	
	93	24.6 (14.4)	20.3 (4.5)	
	94	29.5 (22.6)	21.0 (6.2)	
• Τοταλ χοςτ	90	1090.3 (330.1)	1168.0 (435.6)	Ξ 1000
	91	1210.5 (421.9)	1269.8 (583.9)	
	92	1486.6 (794.5)	1379.2 (695.0)	
	93	1707.4 (1050.0)	1442.9 (690.2)	
	94	2118.5 (1524.0)	1429.5 (500.2)	
• Τοταλ ρεπεινε	90	1024.1 (150.0)	1213.7 (411.7)	Ξ 1000
	91	1238.2 (464.6)	1352.5 (799.5)	
	92	1566.1 (741.7)	1568.1 (821.0)	
	93	1870.2 (1111.0)	1644.6 (843.2)	
	94	1861.8 (1154.0)	1571.5 (644.5)	
Σερπιχε ςτυρυτυρε				
• Νυμερ οφ μεδιγαλ ςερπιχες ενχουντερς / νυμερ οφ ηεαλτη ςερπιχες ενχουντερς	90	52.6 (3.2)	47.5 (4.9)	περχεντς
	91	54.0 (0.8)	46.7 (6.3)	
	92	53.2 (3.1)	49.0 (6.6)	
	93	49.9 (6.1)	51.2 (5.1)	
	94	53.2 (0.2)	56.0 (12.9)	
• Νυμερ οφ οτηερ ηεαλτη ςερπιχες ενχουντερς / νυμερ οφ ηεαλτη ςερπιχες ενχουντερς	90	47.4 (3.2)	52.5 (4.9)	περχεντς
	91	45.9 (0.8)	53.2 (6.3)	
	92	46.7 (3.1)	50.9 (6.7)	
	93	50.1 (6.1)	48.8 (5.1)	
	94	46.8 (0.2)	43.9 (12.9)	
Μανποερ ςτυρυτυρε				
• Νυμερ οφ ηεαλτη ςερπιχες περςοννελς / νυμερ οφ αλλ περςοννελς	90	62.1 (1.6)	62.8 (6.7)	περχεντς
	91	60.3 (9.0)	63.8 (1.8)	
	92	54.3 (10.7)	62.6 (8.6)	
	93	58.8 (0.5)	61.6 (14.2)	
	94	57.7 (1.6)	61.2 (4.2)	
• Νυμερ οφ νον ηεαλτη ςερπιχες περςοννελς / νυμερ οφ αλλ περςοννελς	90	37.8 (1.6)	37.2 (6.7)	περχεντς
	91	36.6 (9.0)	36.1 (1.8)	
	92	45.6 (10.7)	37.4 (8.6)	
	93	41.1 (0.5)	38.4 (14.2)	
	94	42.3 (1.6)	38.8 (4.2)	

Table 1. Continued

Τηλε Πανελ Στυδψ οφ τηε Εφφεχτσ οφ Μεδιχαλ Εδυχατιον ιν Πριμαρψ Σετινγσ

Variables	year	Means(Std. dev.), Frequency and Measurement		
		health centers with medical student training programs	health centers without medical student training programs	measurement/ indices
• Number of medical personnels / number of health services personnels	90	66.7(10.9)	43.1(11.9)	percents
	91	63.9(9.4)	45.6(10.7)	
	92	76.7(23.4)	48.2(6.1)	
	93	65.8(5.4)	44.7(11.3)	
	94	61.8(8.2)	46.8(8.3)	
• Number of ancillary services personnels / number of health sevices personnels	90	18.7(13.3)	23.2(6.1)	percents
	91	21.1(12.4)	19.9(5.2)	
	92	9.9(14.1)	21.5(3.9)	
	93	18.8(8.6)	24.0(7.5)	
	94	14.6(4.2)	22.8(5.5)	
• Number of other health sevices personnels / number of health services personnels	90	14.5(2.4)	33.5(17.2)	percents
	91	14.8(3.1)	34.3(15.5)	
	92	13.3(9.2)	30.2(2.9)	
	93	15.3(3.2)	31.3(17.5)	
	94	23.4(12.6)	31.1(11.7)	
• Number of support services personnels / number of non health services personnels	90	34.3(14.2)	36.6(11.6)	percents
	91	39.3(2.4)	38.3(9.5)	
	92	44.2(3.5)	33.5(23.4)	
	93	42.3(0.8)	24.5(21.5)	
	94	36.4(3.9)	33.5(9.6)	
• Number of clinic overhead personnels / number of non health services personnels	90	65.7(14.2)	63.3(11.6)	percents
	91	60.7(2.4)	61.7(9.5)	
	92	55.7(3.5)	66.5(23.4)	
	93	57.7(0.8)	75.5(21.5)	
	94	63.5(3.9)	66.5(9.6)	
Cost structure				
• Health services cost / total cost	90	73.6(2.9)	74.1(8.8)	percents
	91	72.2(0.5)	74.9(6.8)	
	92	71.0(0.3)	75.8(4.7)	
	93	70.5(1.8)	67.6(8.3)	
	94	70.5(2.1)	67.7(6.2)	
• Non health services cost / total cost	90	26.3(2.9)	25.8(8.8)	percents
	91	27.7(0.5)	25.0(6.8)	
	92	28.9(0.3)	24.1(4.7)	
	93	29.4(1.8)	32.3(8.3)	
	94	29.4(2.1)	32.2(6.2)	
• Medical cost / health services cost	90	66.8(12.2)	50.9(7.1)	percents
	91	65.7(12.6)	58.5(10.8)	
	92	68.5(15.9)	53.4(5.1)	
	93	61.5(5.3)	56.4(6.0)	
	94	64.2(0.2)	57.0(7.6)	

Table 1. Continued

Variables	Means(Std. dev.), Frequency and Measurement			
	year	health centers with medical student train- ing programs	health centers without medical student training programs	measurement / indices
• Ancillary services cost / health services cost	90	20.2(17.2)	27.8(6.1)	percents
	91	20.9(17.0)	26.6(4.6)	
	92	19.3(14.1)	27.0(8.0)	
	93	21.1(14.4)	27.9(4.9)	
	94	20.9(7.0)	27.1(4.1)	
• Other health services cost / health services cost	90	12.8(5.0)	21.1(10.3)	percents
	91	13.3(4.4)	14.7(6.2)	
	92	12.0(1.7)	19.5(10.6)	
	93	17.3(9.0)	15.5(8.1)	
	94	14.7(7.2)	15.7(6.7)	
• Support services cost / non health services cost	90	0.0(0.0)	0.06(0.1)	percents
	91	0.0(0.0)	0.0(0.0)	
	92	0.0(11.2)	0.6(1.2)	
	93	11.7(14.5)	0.6(0.7)	
	94	8.1(8.6)	1.9(3.8)	
• Overhead cost / non health services cost	90	87.6(12.7)	90.2(11.3)	percents
	91	98.4(2.1)	91.1(10.7)	
	92	89.9(11.2)	86.7(13.7)	
	93	88.2(14.5)	90.1(13.4)	
	94	86.5(16.1)	87.7(10.8)	
• Value donated services cost / non health services cost	90	12.3(12.7)	9.6(11.2)	percents
	91	1.5(2.1)	8.8(10.7)	
	92	0.0(0.0)	12.5(12.6)	
	93	0.0(0.0)	9.2(13.1)	
	94	5.2(7.4)	10.2(12.5)	
Revenue source				
• Federal grant revenue / total revenue	90	39.6(7.8)	20.9(8.7)	percents
	91	32.2(4.0)	21.3(12.2)	
	92	26.7(5.7)	16.0(6.6)	
	93	24.0(9.1)	16.6(7.1)	
	94	27.8(6.8)	16.4(5.5)	
• Program income revenue / total revenue	90	41.2(1.9)	55.7(14.4)	percents
	91	43.7(2.6)	52.0(8.4)	
	92	47.5(8.4)	60.4(14.2)	
	93	48.2(5.5)	60.6(13.8)	
	94	47.0(6.4)	58.4(13.7)	
• Other revenue / total revenue	90	19.0(5.8)	23.2(15.1)	percents
	91	23.9(1.4)	26.6(13.0)	
	92	25.7(2.6)	23.5(14.9)	
	93	27.7(3.6)	22.7(16.6)	
	94	25.1(0.4)	25.0(14.6)	

Source: The Bureau of Common Reporting Requirements for Six Health Centers of Cincinnati Health Network, 1990~94.

2. Methods

Comparative analyses of health centers with medical student training programs vs. those without such programs are conducted by using various methods.

First, the structural relationships of each health center, which determine its average costs and productivities, are analyzed. Second, the trends over a five year period from 1990 through 1994 in key variables are conducted with diagrams using statistical tests of differences in time series data. Finally, multivariate analyses are conducted using the panel data to investigate the effects of medical student training programs on the average costs and productivities of health centers, holding constant the effects of other variables that affect cost and productivity. To illustrate trend and multivariate analyses, the models are set as follows: first of all, trend analysis is conducted to gain insights into comparative settings of health centers. Such insights would help us investigate the difference in the changing patterns of costs and productivity between health centers with and without the educational program.

To test the difference in trends (slope of time series data) between the two types of health centers, we exert the trend analysis. Following equation is the basic trend analysis model.

(for centers without medical student training programs)

$$Y_t = a_1 + b_{1t} + e_t \quad t = 1, 2, \dots, s$$

(for centers with medical student training programs)

$$Y_t = a_2 + b_{2t} + e_t \quad t = 1, 2, \dots, s$$

To test $b_1=b_2$ (equality of the changing rates between the two types of centers during 1990~94), we should estimate the following model:

$$Y_t = a_1 + b_1 t + (a_2 - a_1) D_t + (b_2 - b_1) t D_t + e_t \quad t = 1, 2, \dots, s$$

where

$$D_t = \begin{cases} 1 & \text{if there are medical student training programs} \\ 0 & \text{if there are no medical student training programs} \end{cases}$$

The t-value of the estimate of $b_2 - b_1$ can be used to test if $b_2 = b_1$. That is, $b_2 - b_1$ defines the difference in trends (slope of time series data) between centers with and without medical educational programs during 1990~94.

Secondly, the effects of medical student training program on productivity and cost in health centers during 1990~94 are analyzed using a multivariate analysis.

To estimate the productivity or average cost (y_{it}), we set the model as follows:

$$y_{it} = \alpha_0 + \alpha_i + \gamma_t + \sum_{k=2}^K \beta_k \chi_{kit} + \varepsilon_{it}$$

where

$i = 1, 2, \dots, N$ (number of health centers)

$t = 1, 2, \dots, T$ (years)

$k = 2, 3, \dots, K$ (explanatory variables)

IV. Empirical Analysis and Results

1. Descriptive Analysis

In general, a descriptive analysis is conducted to examine the structural relationships of health centers and to understand the principal characteristics or differences of them. Table 1 also presents a comparative description of unit cost, productivity, size-volume, structure and revenue source characteristics for each of the two health centers with medical student training programs and four centers without such programs over the five year period from 1990 to 1994.

In order to study the effects of medical student training on the unit costs and productivities of health centers, their patterns of changes over the past five years are examined for each type of function.

The descriptive analysis found that health centers with medical student training programs showed a more rapid decrease in health services cost per patient encounter than health centers without such programs. Also, the result indicates no difference in relation to both medical costs per patient encounters and other health costs per patient encounters. Among these unit costs, the overhead cost per total encounters increased rapidly, about 50% in health centers with programs and 100% in those without such programs during the five years. In spite of the little difference in terms of unit costs, the result of this analysis seems to prove that medical student programs cause an increase in overall average costs.

The productivities and their patterns of yearly changes analyzed are the staff's productivity of medical service, health service, and

other health services. In terms of medical staff's productivity, the result indicates that productivity has been increasing since the introduction of medical student training programs in 1993. While other health service staff's productivity has been decreasing, the health service staff's productivity in all centers shows a tendency toward an increase.

Figures 1 through 4 show a comparative representation of four variables on size-volume reflecting basic characteristics of health centers. In this study, total encounters, all personnels, total cost and total revenue are examined as the four representative variables on size-volume.

Figure 1 presents the respective sizes of health centers in terms of the number of encounters, which represent the output of each health center. The total encounters of health centers with programs show a tendency to increase compared to the health centers without them. Figure 2 shows the number of staffs employed by each health center over the five year period from 1990 to 1994. Although the size of staff employed by health centers without the programs remained fairly stable during the past five years, health centers with the programs have substantially increased the size of its staffs. With an increase in number of patient visits (output), health centers with the resident or medical student programs have seen their total operating cost increasing rapidly during the past four years, in comparison with other health centers (Figure 3). The operating costs of other health centers have remained fairly stable. In terms of revenue, health centers with any organized medical student training programs had larger revenue during the past five years. Health centers without them had a slightly larger revenue (Figure 4).

Τηλε Πανελ Στυδψ οφ τηε Εφφεχτσ οφ Μεδικαλ Εδυχατιον ιν Πριμαρψ Σεπτινγσ

Figure 1. Size-volume : Number of Total Encounters

Note: Lincoln H. and Mt. Auburn only have medical student training programs.

Figure 2. Size-volume : Number of All Personnels

Note: Lincoln H. and Mt. Auburn only have medical student training programs.

Figure 3. Size-volume : Total Cost

Note: Lincoln H. and Mt. Auburn only have medical student training programs.

Figure 4. Size-volume : Total Revenue

Note: Lincoln H. and Mt. Auburn only have medical student training programs.

Four types of structural relationships and their pattern of changes are analyzed through proportional diagrammatic expositions. The structural relationships analyzed include service structure, manpower structure, cost structure and revenue structure (See Table 1).

These structural relationships and their pattern of changes over the five years from 1989 to 1994 are examined to gain insight into the operational settings of each health center. Such insight would help us investigate the effects of medical student training programs on the average costs and productivity of health centers. Educational programs are hypothesized to influence the cost and productivity of the health center by affecting these structural relationships.

2. Trend Analysis

As shown in Table 2, the analysis results show that all variables related to "size-volume" which is represented by the number of total encounters, the number of all personnels, total cost and total revenue have more statistically significant changes than other structure variables between the two types of health centers during 1990~94. This may be due to the fact that variables measured by total number rather than by ratio present more information on the overall changes associated with medical student training programs between them. Namely, these results imply that the variables measured by ratio are most likely to spread by the minute and by the specific changes related with such programs.

With regard to unit costs by cost category, the overhead cost per total encounters is only shown to have a significant difference between the two types of health centers. The results indicate that the overhead cost of health centers with medical student training programs has been

Table 2. The Test of Significance of Result of Trend Analysis

Variables	$b_2 - b_1$	t-value
Unit Cost by Cost Category		
• Health services cost / number of health services encounters	0.245	0.262
• Medical cost / number of medical encounters	0.263	0.600
• Other health cost / other health services encounters	0.267	0.361
• Overhead cost / number of total encounters	-0.767	2.330*
Productivity - Output Measured by The Number of Encounters		
• Number of medical encounters / number of medical personnels	0.011	0.035
• Number of other health services encounters / number of other health services personnels	-0.075	0.092
• Number of health services encounters / number of health services personnels	-0.166	0.455
Size-volume		
• Number of total encounters	1.901	6.922***
• Number of all personnels	1.773	3.366**
• Total cost	1.173	5.967***
• Total revenue	0.885	2.846**
Service Structure - Unit : Number of Encounters		
• Number of encounters for medical services / number of health services encounters	-1.560	3.192**
• Number of encounters for other health services / number of health services encounters	1.560	3.192**
Manpower Structure - Personnel-Mix		
• Number of health services personnels / total number of personnels	-3.336	0.549
• Number of non health services personnels / total number of personnels	3.336	0.549
• Number of medical personnels / number of health services personnels	-0.199	0.587
• Number of ancillary services personnels / number of health services personnels	-0.604	0.865
• Number of other health services personnels / number of health services personnels	0.565	2.298*
• Number of support services personnels / number of non health services personnels	0.951	1.298
• Number of overhead personnels / number of non health personnels	-0.951	1.298
Cost Structure(as Measured by Unit Cost)		
• Health services cost / total cost	0.812	1.321
• Non health services cost / total cost	-0.812	1.321
• Medical cost / health services cost	-0.623	1.568
• Ancillary services cost / health services cost	0.087	0.511
• Other health services cost / health services cost	1.175	1.724
• Support services cost / non health services cost	0.956	1.877
• Overhead cost / non health services cost	-0.350	0.374
• Value donated services cost / non health services cost	-0.672	0.982
Revenue Structure(as Measured by Revenue Sources)		
• Federal grant revenue / total revenue	-0.450	0.982
• Program income revenue / total revenue	0.053	0.165
• Other revenue / total revenue	1.278	1.781

Note: *** $P \leq 0.01$ ** $0.01 < P \leq 0.05$ * $0.05 < P \leq 0.10$

reduced. However, the productivities measured by the number of encounters is small enough to suggest that the productivities of the centers with residents and medical school students are higher than that of the non-training health center.

The results related with size-volume show that the introduction of medical student training program in health center has increased the number of total encounters and all personnels, total cost and total revenue. These are strong evidences that education programs in health center have a favorable influence on improving the size-volumes and qualities of health center such as encounters, personnels, cost or revenue.

Figures 5 through 8 show a comparative analysis of yearly trend in the size-volume of health centers. Results are discussed with reference to descriptive analysis on size-volume. These figures provide better graphical understanding on the sensitive changes of size-volume. The number of total patient encounters of health centers with such training programs increases gradually over time but that of health centers without them decreases sharply (see Figure 5). In the case of number of all personnels, the health centers with the programs (see Figure 6) have a tendency to recruit staffs, whereas health centers without them maintain a stable level on a levy plan. In terms of total cost, Figure 7 shows that total cost of health centers with medical student training programs increase more rapidly than that of health centers without such programs. This result is expected. A number of studies on measuring the costs of medical student or resident training in ambulatory care settings have reached a consensus that teaching medical students reduces physicians' productivity and increases the overall costs of ambulatory care setting.

Figure 5. Comparative Analysis of Yearly Trend in Size-volume of Health Centers : No. of Total Encounters (on-site only)

Note: —+— medical educational programs
---x--- no medical educational programs

Figure 6. Comparative Analysis of Yearly Trend in Size-volume of Health Centers : No. of All Personnels

Note: —+— medical educational programs
---x--- no medical educational programs

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Figure 7. Comparative Analysis of Yearly Trend in Size-volume of Health Centers : Total Cost

Note: —+— medical educational programs
---x--- no medical educational programs

Figure 8. Comaprative Analysis of Yearly Trend in Size-volume of Health Centers : Total Revenue

Note: —+— medical educational programs
---x--- no medical educational programs

Figure 8 presents that the growth in the total revenue of health centers with such programs outruns that of health centers without them after 1992. This means that, despite the increase in total cost, the increase in the number of patient's visit to health centers offset the increment in the cost.

With respect to service structure, the ratio of the number of encounters for medical services to that of health services encounters is decreasing in health centers with such programs. These centers are likely to treat relatively more other health services except for the medical services per health services encounters.

Not only do the results for cost structure measured by unit cost show statistically insignificant differences in trends, but revenue structure measured by sources also reveals statistically insignificant ones between the two groups.

3. Multivariate Analysis

The effects of medical student training program on productivity and cost in health centers during 1990~94 are analyzed by using the panel data analysis or multivariate analysis with pooled cross-sectional and time-series data.

The purpose (see Table 3) is to estimate the effect of medical student training programs on productivity in health center using panel data and to estimate the effect of such programs on average cost presented in Table 4. All models estimated have *R*-squared values, as a measure of goodness-of-fit to the model, of 0.83 or higher and plausible parameter estimates.

As shown in Table 3, the results of the first issue are classified

into three kinds of productivity, which are measured as the ratio of the number of medical encounters to its personnels (P_1), the ratio of the number of other health services encounters to its personnels (P_2) and the ratio of the number of health services encounters to its personnels (P_3).

Table 3. Multivariate Analyses of the Effect of Medical Student Training Program on Productivity in Health Centers, 1990~1994

Dependent variables: (Productivity variables)	No. of medical encounters/no. of medical personnels	No. of other health services encounters/no. of other health services personnels	No. of health services encounters/no. of health services personnels
Medical student training programs	-0.39 (1.12)	-0.39 (1.65)*	1.67 (0.07)
Service Structure			
• No. of medical services encounters / no. of health services en.	0.00 (.00)	-0.30 (1.65)*	0.56 (3.27)***
Manpower Structure			
• No. of medical personnels / no. of health services personnels	-0.10 (0.66)	1.15 (5.02)**	-0.28 (1.25)
• No. of overhead ²⁾ personnels / no. of non health services personnels	-0.26 (2.89)***	-0.14 (0.93)	0.17 (1.30)
Cost Structure			
• No. health services cost / health services cost	0.42 (3.26)***	0.20 (1.11)	-0.39 (1.83)*
• Ancillary services cost / health services cost	0.48 (2.24)**	0.14 (0.60)	-0.98 (3.02)***
• Overhead cost / non health services cost	0.39 (2.35)**	0.20 (0.83)	-0.77 (3.11)***
Revenue Structure			
• Federal grant revenue / (program income+other) revenue	0.11 (0.85)	-0.05 (0.25)	-0.28 (1.35)
R-squares³⁾			
• Total (F-value)	0.96 (13.51)***	0.83 (2.91)**	0.93 (7.87)***

Notes: 1) *** $P \leq 0.01$ ** $0.01 < P \leq 0.05$ * $0.05 < P \leq 0.10$

2) Overhead = administrative + facility

3) Adjusted R-squares are 0.8860, 0.5420 and 0.8099 respectively.

Table 4. Multivariate Analyses of the Effect of Medical Student Training Program on Average Cost in Health Centers, 1990~1994

Dependent variables: (Average cost variables) Independent variables	Health services cost/ health services encounters	Medical cost/no. of medical encounters	Other health cpst/other health services encounters	overhead cost/no. of total encounters
Medical student training programs	-0.49 (1.68)*	62.24 (1.69)*	-0.06 (0.22)	0.09 (0.08)
Productivity				
• No. of health services encounters / no. of health services personnels	-0.52 (4.40)***	0.97 (2.71)**	0.81 (4.18)***	0.40 (6.99)***
Service Structure				
• No. of med. services encounters / no. of health services encounters	-0.08 (0.70)	-0.82 (2.56)**	0.02 (0.07)	0.18 (3.28)**
Manpower Structure				
• No. of medical personnels / no. of health services personnels	0.89 (6.34)***	0.11 (0.32)	-0.26 (1.10)	0.05 (0.79)
• No. of overhead ²⁾ personnels / no. of non health services personnels	-0.20 (2.51)**	-0.02 (0.11)	-0.14 (0.90)	0.02 (0.48)
Cost Structure				
• Non health services cost / health services cost	0.11 (0.39)	0.45 (0.56)	-0.23 (0.53)	0.36 (2.57)**
• Ancillary services cost / health services cost	0.38 (1.90)*	0.07 (0.11)	-0.59 (2.51)**	0.06 (0.52)
• Overhead cost / total cost	0.15 (0.56)	0.02 (0.02)	0.04 (0.09)	0.29 (2.10)**
Revenue Structure				
• Federal grant revenue / (program income+other) revenue	-0.08 (0.70)	0.65 (2.09)*	-0.25 (1.25)	0.03 (0.60)
R-squares³⁾				
• Total (F-value)	0.97 (17.20)***	0.85 (2.94)**	0.87 (3.51)**	0.99 (96.79)***

Notes: 1) *** $P \leq 0.01$ ** $0.01 < P \leq 0.05$ * $0.05 < P \leq 0.10$

2) Overhead = administrative + facility

3) Adjusted R-squares are 0.9139, 0.5592, 0.6219 and 0.9843 respectively.

The productivity P_1 is found to be positively influenced by cost structure, whereas productivity P_3 is negatively influenced. Therefore, this result shows that productivity could be improved by handling the

cost structure. The increase in the ratio of medical personnels to the number of health services personnels improves productivity P_2 and the decrease in the ratio of the number of overhead personnels to the number of non health services personnels increases productivity P_1 . When physicians productivity is measured by the ratio of medical encounters per physician, the productivity P_1 is found to be statistically insignificant. Health centers with medical student training programs show less productivity P_2 than those without such programs. These programs are also found to have a positive effect on productivity P_3 , yet, statistically insignificant.

Estimations in Table 4 show how all structures including medical student training program have significant effects on the average costs measured by the various ratios measured by: the ratio of the health services cost to its encounters (AC_1), the medical cost to its encounters (AC_2), other health costs to its encounters (AC_3) and the overhead cost to the number of total encounters (AC_4).

Above all, the results show that medical student training programs have a significantly negative effect on AC_1 and a positive effect on AC_2 . These programs exert a positive effect on decreasing the average health services cost, and increasing the average medical cost. Productivity P_3 is found to positively influence all average costs excluding average cost AC_1 . That is, the increase in the number of health services encounters per its personnels lowers the health services cost per its encounters.

The ratio of the number of medical services encounters to the number of health services encounters is found to be negatively associated with average cost AC_2 related to medical cost, and positively associated with average cost AC_4 related to overhead cost.

An increase in health services cost per its encounters AC_1 is affected by increasing manpower structure related to medical personnels and by decreasing the structure related to overhead personnels. Average cost associated with overhead cost AC_4 is positively influenced by increasing the non health services cost per health services cost or the overhead cost per total cost. The only medical cost per its encounters AC_2 is positively affected by increasing the share of the federal grant revenue over program plus other revenue.

As mentioned above, all models of panel data analyses show a strong statistical relationship between the variables "medical student training programs" and each structure and the variables "productivity" or "average cost" to result in a large ratio of explained to unexplained variance. The F test also shows the significance of these models at levels of 0.05 or less.

V. Discussion

The objective of this study was to arrive at an estimate of costs and productivities of medical student training programs in health centers, not in hospitals, and to be able to identify and quantify the key components of these programs.

To achieve this, various statistical analyses were used. First, the difference between health centers with such programs and those without them was investigated using descriptive analysis and trend analysis. The variables representing the health centers' characteristics were chosen and compared to find out the difference. Then factors

affecting the health center cost were hypothesized. These factors were analyzed by multivariate analysis to understand the relationship among the factors and process through which medical student training program affects the productivity and cost.

Previous work on measuring the costs of physician training in ambulatory care settings has reached a consensus that "teaching under-graduate medical students reduces physicians' productivity and increases the overall costs of ambulatory care setting" (Garg, et al., 1991). The research is ambiguous clear about the effects of resident programs on ambulatory costs (Barnett, et al., 1989; Lave, 1989; Eisenberg, 1990). Although some of these studies (but not all) have found that productivity of teaching physicians may be lowered by having to supervise the residents who produce billable services that offset the productivity loss.

The major results from this study show the following: first, this study found that health centers with medical student programs have a tendency towards greater increase than health centers without such programs in terms of size-volume represented by total encounters, all personnels, total cost and total revenue; and second, the study also made an attempt to identify and quantify the key components of medical student training programs in health centers. As the result, we found some useful implications by using the multivariate analyses.

The results of this study are summarized as follows: first, inner city health centers with medical student training programs show more increase in the size/volume of total patient encounters, all personnel, and total cost and total revenue than health centers without such programs. Second, when physicians productivity is measured by the ratio of medical encounters per physician, the

productivity is found to be statistically insignificant. Third, medical student training programs exert a positive effect on decreasing the average health services cost, and increasing the average medical cost. Finally, productivity measured by health services encounters per its personnels is found to positively influence all average costs excluding health services cost per its encounters. That is, the increase in the number of health services encounters per its personnels lowers the health services cost per its encounters.

No policy recommendations are made based on the results of the present study. The results, however, contain some policy implications. To translate these implications into concrete actions, health center administrators should look into the aspects of health center operations which are emendable. This study covers a relatively small area of health center operations. Of course, any policy decision that may be derived from this study must consider the factors affecting health centers which are not within the province of this study.

Even on the subject-matters examined here, the results are not always conclusive. A policy maker should acquaint himself with other studies previously undertaken, and those which will follow, and should make a judgment on what use can be made of this study for the purpose on hand.

It is hoped that the result of this study promotes the search for a new and more effective approach toward improvement of birth outcomes and infant's health.

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요 약

一次醫療機關에서의 醫療教育效果에 대한
패널研究

李 澗 植

2·3차 병원급 이상의 의료기관에서 수련하는 인턴, 레지던트의 의료 교육(Medical Education Training Programs)의 효율성을 논하는 많은 연구들이 있어 왔다. 그러나 1차진료를 담당하는 보건소(Health Center) 단위에서 수련의의 의료교육실시에 따른 경제적 효과에 대해서는 아직 충분한 연구가 수행되지 못한 실정이다. 따라서 본 연구에서는 의료자원의 효율적 분배를 모색한다는 취지에서 보건소에서의 의료교육실시에 따른 비용 및 생산성에 미치는 영향에 대해 연구하였다. 이를 위하여 미국 신시내티 보건네트워크안에 있는 6개 보건소를 선정하여 이들의 1990부터 1994년까지의 패널자료를 중심으로 분석하였다.

의료교육프로그램이 보건소의 단위 생산성과 비용에 미치는 구체적 관계를 도출하기 위하여 자료를 7개의 구조변수(Structural Variables)로 나누고 추세분석(Trend Analysis) 및 다변량분석(Multivariate Analysis)을 사용하여 제 변수의 추세 변화, 비용 및 생산성에 영향을 미치는 제 요인에 관해 살펴보았다. 분석 결과에 의하면 의료교육프로그램의 도입으로 인해 총방문환자수, 총의료인수, 총비용 및 총수익에 변화가 발생하였다. 특히 의료서비스를 받기 위해 방문한 환자수로 측정된 의사의 생산성은 의료교육실시로 인해 별 영향을 받지 않는 것으로 조사되었다. 또한 의료교육실시는 1차진료기관의 의료서비스 방문건당 의료서비스의 비용(Health Services Cost)을 줄이는 효과를 보임에 반해 의사방문건당 비용(Medical Cost)은 증가하는 것으로 나타났다.