On Grouping Hospitals for Cost Analysis

Ik-Whan Kwon
St. Louis University

Jacqueline D. Frasca
Cardinal Glennon Memorial Hospital for Children

Joe H. Kim
Rider College

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The unheralded developments in the supply side of hospitals' services and facilities demand a new taxonomy and evaluation to compare and contrast the providers' operating characteristics and their relative efficiencies. In a 1965-1966 study, Berry (1973) investigated the patterns of hospitals' product mixes in order to explain differences in the production and cost relationship of their services and facilities. He believed that if hospitals showed certain systematic patterns that affected breadth and depth in the assortment of services and facilities, those patterns would provide an equitable basis for comparing their production costs. Berry's study indicated that their product mixes could be categorized into four clear, systematic patterns: the basic, the quality-enhancing, the complex, and the community types.

According to his observations, some hospitals limit their product mix to basics. However, as hospitals add facilities and services, there is a strong tendency to enhance the quality of their basic services by increasing the depth of these assortments. Only after the quality enhancing services have been acquired do short-term general hospitals show a tendency to diversify to complex assortments. The final stage of expansion comes when hospitals so increase their assortments that they essentially transform themselves from inpatient-oriented institutions to community medical centers. A close relationship is also apparent between the product mix and the size of hospitals during the developmental stages.

This categorical framework enabled the present researchers to compare and contrast differences in product mixes and cost functions among hospitals (Berry, 1970; Carr and Felstein, 1967). Furthermore, this approach will avoid the cost analysis problems associated with the product mix which was acknowledged by Newhouse (1970).

Berry indicated that hospitals offering community-type assortments usually have the longest period of stay, larger numbers of interns and residents, the highest average cost per patient day, the highest average annual wage rate, and the highest capital-to-labor ratio.

Since Berry's study, several significant changes have occurred in the health care field. The unprecedented rise of proprietary hospitals (Relman, 1980), multi-hospital systems (Brown et al, 1980), and increasing participation in shared services (Taylor, 1977; Wegmiller, 1979) are only a few developments of the health care industry since the early 1970s. The share of health care expenditures in the gross national product has increased from 4.7 percent in 1974 to 13 percent in 1980.

While supporting Berry's findings, this investigation attempts to reevaluate the proposed theory of hospital product mix based on data for 1974 and 1978. It adds a new perspective by incorporating product and cost functions by the types of ownership of hospitals.

The implication of this study is broad and far reaching, because if Berry's proposition remains valid, economic policy on health care and cost containment should be re-examined according to the determinants that affect hospital's product mix. The health care financing policy based on diagnosis related groups (DRG) might have been the logical outcome from hospital production function.

STUDY METHOD

A cross-sectional analysis was performed, based upon the major operating characteristics and performance variables within all hospital categories. This approach provides standard criteria by which the different types of hospitals can be equitably compared.

The American Hospital Association's (AHA) Hospital Data Tape was the major source of data for this investigation. The AHA gathered the information through its 1975 and 1979 questionnaires sent to every U. S. hospital. The information was condensed and published, in 1976 and 1980, under the title, *A Guide to Health Care Field*. All short-term acute general hospitals that had been operating at least one full year were used in the study. These hospitals were placed into one of three major categories: proprietary, not-for-profit or governmental.

Of the elements of the product mix used in Berry's study, such services as clinical laboratories, operating rooms, chaplaincies, chapels, routine chest X-rays and blood sugars on admission were no longer reported to the American Hospital Association. These were replaced in this study by organ banks, open heart surgery facilities, clinical psychology services, and pediatric services. Substitution of those services, therefore, should not distort the results of this investigation.

To evaluate the cost performances in depth, the hospitals were grouped according to Berry's scheme of hospital product mix. This classification enabled us to determine the average expenditures per patient day within different types of hospitals. Berry's grouping was slightly modified for this study by adjusting the services and facilities (Kwon et al, 1981).

To group the hospitals, a 30 by 30 element matrix was constructed with the number of facilities and services forming the columns of the matrix. Thus a given element of the matrix, a_{ij}, would indicate the number of i facility hospitals that had the jth facility. (For example, how many 10-facility hospitals have a blood bank?)

The pattern of facilities and services within profit and not-for-profit sectors emerged when the matrix was analyzed by means of a special algorithm. The algorithm classified the hospitals into four different groups based upon the numbers and types of services and facilities each hospital offers.

There are essentially four major types of product mixes, and most hospitals can be categorized according to these types: (1) basic types, (2) quality-enhancing type, (3) complex-type, and (4) community type.

The specific algorithm used in this study was: A hospital belongs in the community type if it has three or more of the community type services, e.g., an organ bank; if it has five or more complex services, e.g., cobalt therapy, it belongs in the complex group; if it has three or more of the quality-enhancing services, e.g., dental services, it belongs in that group; if it does not fit into any of the first three groups, it belongs in the basic service group. Table 1 lists the services used in this classification.

TABLE 1
Classifying Hospitals into Service Categories

Basic Services

Emergency Department
Postoperative Recovery Room
Physical Therapy Department
Hospital Auxiliary
Respiratory Therapy

Quality-Enhancing Services

Diagnostic Radioisotope Facility
Blood Bank
Histopathology Laboratory
Pharmacy w/FT Registered Pharmacist
Electroencephalography
Dental Service
Intensive Care Unit (Mixed)
Social Work Department

Complex Type Services

X-ray Therapy
Therapeutic Radioisotope Facility
Psychiatric Inpatient Unit
Cobalt Therapy
Radium Therapy
Occupational Therapy Department
Organized Outpatient Department
Speech Pathology Services
Premature Nursery
Clinical Psychology Services

Community Type Services

Organ Bank
Open Heart Surgery Facilities
Burn Care Unit
Home Care Department
Rehabilitation Inpatient Unit
Family Planning Services
Podiatric Services

Finally, the average expense per patient day was estimated for each group of hospitals classified by product mix.

FINDINGS AND DISCUSSION

This investigation led to several significant findings related to the growth patterns of hospitals' product mix and the relationship of that pattern to the sizes of hospitals.

A. Types of Product Mix. To test the product mix patterns claimed by Berry and to determine the mutual effects between the categories of hospitals and the types of product mix, the data were cross-tabulated (see Table 2). Because the data include at least 50 percent of all hospitals with similar characteristics, all facilities and services common to the hospitals are sufficiently represented. For example, respiratory therapy was found in at least 50 percent of all hospitals with basic features in 1974.

While Berry's claim was generally confirmed by this investigation, several new findings also deserve to be noted. First, Berry's contention that a systematic pattern exists in the product mix seems to hold over three developmental stages of product mix. About five basic facilities and services constitute the hospital product mix during the first stage prior to the addition of the quality-enhancing features. After the basic services are established, hospitals seem to begin to add elements that can be characterized as quality-enhancing. Hospitals then combine such complex features as out-patient services, occupational therapy, and clinical psychology. Hospitals in this category provide approximately twenty facilities and services. While Berry classified the social work department and occupational out-patient services under the category of community-type product mix, this study shows that they fall into quality-enhancing or complex-type mixes. It appears certain that facilities and services once thought to be prohibitively expensive and complex are now considered standard in many hospitals. This development will become more apparent when the sizes of hospitals are correlated with the types of product mixes that the hospitals offer.

Finally, Berry's study indicated that few proprietary hospitals added the community-type product mix. For example, no proprietary hospital during his study period provided such services as social work, rehabilitation, and family planning. In fact, the absence of such services was apparent until 1974. However, the proprietary hospitals began to offer all community-type facilities and services except burn-care units in 1978. As a result, the proprietary hospitals marked the highest expansion in their assortments between 1974 and 1978. As shown in Table 2, the mean value for all hospitals increased from 9.5 services per hospital in 1974 to 11.6 services in 1978, a 21.2 percent gain, whereas the corresponding figures for the proprietary hospitals jumped from 5.8 to 9.2, an increase of 57.2 percent.

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TABLE 2
Status Of Hospital Product Mix:
Present in 50 Percent of All Hospitals
1974 & 1978

Product Mix Elements by Category	1974				1978			
BASIC SERVICES	All	N¹	G²	P³	All	N¹	G²	P³
Emergency Department	2	2	1	4	2	2	1	5
Postoperative Recovery Room	4	4	4	4	5	5	5	5
Physical Therapy Department	6	6	6	6	5	4	5	6
Hospital Auxiliary	4	2	4	12	5	4	5	11
Respiratory Therapy	6	6	6	4	5	5	5	5
QUALITY-ENHANCING								
Diagnostic Radioisotope Facility	11	11	12	9	11	11	11	10
Blood Bank	7	7	7	8	7	7	6	8
Histopathology Laboratory	11	10	11	8	11	11	11	10
Pharmacy w/FT Registered Pharmacist	8	8	8	6	8	8	8	5
Electroencephalography	13	13	15	10	12	12	12	10
Dental Service	14	17	12	14	14	15	12	15
Intensive Care Unit (Mixed)	8	7	8	8	8	8	8	13
Social Work Department	10	10	9	10	9	9	9	10
COMPLEX EXPANDING								
X-ray Therapy	16	14	19	16	17	17	19	18
Therapeutic Radioisotope Facility	17	16	18	17	17	17	18	17
Psychiatric Inpatient Unit	19	19	17	17	19	19	17	19
Cobalt Therapy	21	21	21	18	21	21	22	19
Radium Therapy	17	16	20	17	19	19	21	18
Occupational Therapy Department	20	21	17	20	18	18	16	17
Organized Outpatient Department	17	19	16	—	18	18	15	18
Speech Pathology Services	19	19	22	18	16	16	18	17
Premature Nursery	14	14	14	16	17	17	17	18
Clinical Psychology Services	22	22	19	—	21	21	19	20
COMMUNITY TYPE								
Organ Bank	27	28	17	—	28	28	27	27
Open Heart Surgery Facilities	23	23	23	—	24	24	24	21
Burn Care Unit	29	29	26	—	28	29	27	—
Home Care Department	29	27	30	—	27	26	—	25
Rehabilitation Inpatient Unit	26	27	30	—	27	27	25	25
Family Planning Services	24	24	24	—	25	25	24	24
Pediatric Services	25	25	25	—	23	24	19	19
Mean Values	9.5	12.1	8.6	5.8	11.6	13.2	10.0	9.2

1. Not-for-profit hospitals
2. Government Owned or Operated Hospitals
3. Proprietary Hospitals

The gain experienced by proprietary hospitals coincided with a rapid growth in numbers of proprietary hospitals in the U. S. In 1968, there were only 769 proprietary hospitals, about 11 percent of the total. There are now over 1,000 proprietary hospitals, 15 percent of the total, generating a gross annual income of 12 billion dollars and still growing at the rate of 15 to 20 percent per year (Relman, 1980).

B. Product Mix and Size of Hospital. What is the interacting effect between the product mix and the size of a hospital? When the product mix was cross-tabulated with the size of a hospital to see their mutual effect, it led to several new patterns. The number of beds of the basic service hospital is extremely low in comparison to others; the average size is about 50 beds, as shown in Table 3.

Transition from the basic to the quality-enhancing level did not significantly change the size of hospitals. The average number of beds for the quality-enhancing hospitals is over 100 beds. However, the addition of complex and community type services to the quality-enhancing features increased the number of hospital beds considerably. The average number of beds for complex and community-type hospitals was 320 and almost 600 respectively, in 1978.

These findings basically concur with Berry's contention. There is a strong and statistically significant relationship between the type of product mix and the size of hospitals. Accordingly, it seems logical to think that hospitals increased their number of beds when they expanded their product assortments.

While Berry's findings are still valid, one significant new development is evident. As discussed earlier, the average number of services increased for all types of hospitals between 1974 and 1978. However, Table 3 indicates that the average number of beds actually decreased during the same period for all types of hospitals including proprietary hospitals. These seemingly conflicting results appear attributable to the technological advances in the health care industry during the last decade. The new medical technology could have made it more feasible for smaller hospitals to provide services and facilities once considered prohibitively expensive. For example, such features as diagnostic radioisotope, electroencephalography, dental services and intensive care units were considered as complex-type during Berry's research period. They are now considered only as quality-enhancing features. Furthermore, many proprietary hospitals now own and operate community-type facilities and services in spite of the fact that their average bed size exceeds 120 (see Table 3). As a result, the overall bed size in the 1978 study decreased for all types of hospitals.

C. Product Mix and Operating Characteristics. Are hospitals with one kind of product mix different from those with other types in their operating characteristics? When the interactions between the product mix and important operating characteristics were compared and contrasted among hospitals, several persistent differences were found during the two periods.

TABLE 3
Status Of Product Mix And Bed Size:
Present in 50 Percent of All Hospitals
1974 & 1978

Elements by Product Mix Category BASIC SERVICES	Mean Bed Number 1974				Mean Bed Number 1978			
	All	N[1]	G[2]	P[3]	All	N[1]	G[2]	P[3]
Emergency Department	37	34	35	53	39	37	29	55
Postoperative Recovery Room	49	45	50	53	55	59	51	55
Physical Therapy Department	63	64	62	61	61	59	50	60
Hospital Auxiliary	49	34	50	138	50	32	50	136
Respiratory Therapy	63	64	62	53	61	61	57	53
QUALITY-ENHANCING								
Diagnostic Radioisotope Facility	132	130	134	92	116	118	108	121
Blood Bank	68	70	65	91	65	70	58	81
Histopathology Laboratory	132	110	132	91	116	118	108	121
Pharmacy w/FT Registered Pharmacist	78	80	72	61	71	73	67	55
Electroencephalography	167	175	179	113	131	134	120	121
Dental Service	176	262	134	150	167	193	120	110
Intensive Care Unit (Mixed)	78	70	72	91	71	73	67	130
Social Work Department	103	110	78	113	87	96	72	121
COMPLEX EXPANDING								
X-ray Therapy	253	172	425	207	252	256	346	110
Therapeutic Radioisotope Facility	266	245	335	224	252	256	312	223
Psychiatric Inpatient Unit	348	577	281	224	316	321	251	180
Cobalt Therapy	430	388	589	223	363	348	414	180
Radium Therapy	266	245	392	224	316	270	365	155
Occupational Therapy Department	370	385	280	288	274	321	219	223
Organized Outpatient Department	266	577	277	—	274	270	154	155
Speech Pathology Services	348	326	515	223	373	362	341	227
Premature Nursery	176	172	200	207	252	229	251	155
Clinical Psychology Services	448	414	625	—	449	426	341	215
COMMUNITY TYPE								
Organ Bank	699	661	620	—	674	656	755	131
Open Heart Surgery Facilities	524	503	577	—	556	550	591	130
Burn Care Unit	1085	1053	785	—	674	993	755	—
Home Care Department	1085	684	1015	—	684	596	—	150
Rehabilitation Inpatient Unit	713	684	785	—	684	682	628	150
Family Planning Services	545	500	607	—	617	629	591	68
Pediatric Services	622	566	715	—	570	673	470	—
Mean Values	304.6	289.8	331.7	139.4	276.8	281.6	281.5	126.9

1. Not-for-profit hospitals
2. Government Owned or Operated Hospitals
3. Proprietary Hospitals

TABLE 4
Product Mix and Operating Characteristics

Operating Characteristics by Year/ Product Mix Type	Length of Stay		Occupancy Rate(%)		Interns & Residents Per Bed		Depreciation Per Bed ($)		Average Cost Per Patient-Day ($)	
	1974	1978	1974	1978	1974	1978	1974	1978	1974	1978
Basic	6.9	6.9	59.8	55.3	nr	0.04	883.12	1320.08	59.80	136.70
Quality-Enhancing	7.4	7.4	67.4	65.5	nr	0.05	1,172.26	2,400.43	67.40	190.44
Complex	8.5	8.0	72.5	71.6	nr	0.08	1,562.41	2,284.20	72.50	215.22
Community	10.4	10.0	79.8	79.0	nr	0.15	1,928.81	3,399.10	79.80	244.36
Total	8.3	7.9	67.5	66.4	nr	0.08	1,420.11	2,777.55	128.83	210.52

nr: Not reported.

TABLE 5
Product Mix and Average Cost Per Patient Day

Types of Hospital Product	Total		Not-for-Profit		Proprietary		Governmental	
Mix Type	1974	1978	1974	1978	1974	1978	1974	1978
Basic	$ 81.32	$136.70	$ 80.49	$137.10	$ 89.28	ns	$ 79.64	$105.60
Quality-Enhancing	107.01	190.44	109.60	190.42	113.70	$200.45	99.68	182.63
Complex	132.82	215.22	132.07	215.27	130.54	147.77	ns	ns
Community	187.52	244.36	197.41	244.36	ns	ns	179.88	ns
Total	128.83	210.52	129.56	210.60	116.11	177.15	129.95	164.00

ns: Not sufficient sample to compute the values.

As presented in Table 4, basic-service hospitals marked lower occupancy rate and length of stay than community-type hospitals. Basic-type hospitals also staffed fewer interns and residents per bed than community type hospitals in 1978.

The average cost per patient-day for the basic service hospitals was far lower than for community-type hospitals, perhaps because community-type hospitals maintain more physical assets per bed than other types of hospital.

D. Product Mix and Costs per Patient-Day. Do not-for-profit, proprietary and government hospitals show different cost behaviors? To compare and contrast cost performances among hospitals, average costs per patient-days were cross-tabulated with types of product mixes and hospital ownership. The result of these analyses is presented in Table 5. Cost performances were almost identical for all forms of hospitals in 1974. However, in 1978 proprietary hospitals marked a much lower average cost per patient day than not-for-profit hospitals.

CONCLUSION

This investigation generally reaffirmed Berry's claims about product mix patterns. The sequential development from basic to quality-enhancing to complex and community types of offering was an unmistakably apparent pattern. Recently more hospitals have added complex and community-type services to their basic and quality-enhancing facilities and services. That trend has been most evident in proprietary hospitals. Proprietary hospitals now provide almost all the community-type facilities and services once considered overly expensive. A dramatic change in the mix of services and facilities occured between 1974 and 1978, although the average bed size of proprietary hospitals remained considerably lower than that of other types of hospitals.

As well as confirming the validity of Berry's proposition, this study attempted to answer several important questions. What are the interacting effects between the product mix and the size of hospitals? Generally basic-type hospitals provide the smallest number of beds. Apparently the most visible increase in the number of beds comes during the transition from quality-enhancing to complex and community product mixes.

Do hospitals providing one kind of product mix show different operating characteristics from those providing different mixes? Notable differences were found in the use of manpower, the size of assets and the average cost per patient-day per bed among hospitals providing different mixes.

Is either the not-for-profit, proprietary, or government hospitals necessarily more cost-efficient than the others? While cost performances were almost identical for all groups in 1974, proprietary hospitals outperformed not-for-profit hospitals in 1978.

It is remarkable that proprietary hospitals were able to finance complex or community-type product mixes without subsequent increases in their bed size and the average costs per patient-day as compared to other types of hospitals. If proprietary hospitals can maintain and operate complex and community-type facilities and services with a limited number of beds and at lower costs, can other types of hospitals learn from this feat?

If the above conclusions are true, they should provide some insights into the workable community health plans and the fair application of health regulations.

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Ik-Whan Kwon is Chairman of the Department of Management Science at St. Louis University. Jacqueline D. Frasca is Director of Medical Records Services at Cardinal Glennon Memorial Hospital for Children in St. Louis. Joe H. Kim is an Associate Professor of Marketing at Rider College.