Hospital Costs and Quality of Care: An Organizational Perspective[1]

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Based on survey data gathered from 388 government non-federal and voluntary general service hospitals, this study examines the impact of several dimensions of organizational structure on indicators of hospital efficiency and level of adoption of new medical technology. Attention is focused on the degree to which resource allocation decision making is centralized and levels of visibility of medical and economic consequences. The evidence presented suggests that, in terms of efficiency, organizational structure is an important factor in determining whether gains in effectiveness outweigh expenses associated with the adoption of new medical technology.

Within a predictive framework this paper will deal with the relationships among several dimensions of organizational structure and performance and their impact upon the quality and cost of care provided by hospitals. An assumption often made is that modern medical technology is costly. Clearly hospital medical costs are rising with a large percentage of the rise due to increased delivery of new and improved medical services made possible by advances in medical technology.

However, it is less clear that new medical technology increases the cost for care. Indeed, the argument can be made that by increasing the ability to treat illness, technology which facilitates higher quality care may be reducing patient care costs. A major problem in dealing with the effect of technology on efficiency is the difficulty in employing econometric methods to non-profit areas such as health. Lave and Lave (1970b:294) state, "The difficulties in estimating hospital costs and production functions are overwhelming. . . ." As a result of the difficulties in assessing quality of care from an

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economic perspective, many investigators have discussed medical cost reduction with little reference to the level of care provided. A consideration of both efficiency and quality measurements is necessary if we are to adequately deal with the question of the utility of expenditures for health care.[2] Further, to our knowledge little large-scale empirical research has been conducted on the impact hospital structure has on quality of care and efficiency. Two structural factors, the degree of centralization of decision making and the levels of visibility of medical and economic consequences in a hospital, are seen as having predictable impact on both quality of care and efficiency. Before presenting our theoretical framework, it will be useful to specify how both the independent and dependent variables have been conceptualized for purposes of this paper.

Quality of Care

Quality of care is an elusive factor to measure. It would appear at first easy to compare hospitals in terms of the morbidity and recidivism rates of a representative sample of patients. However, comparisons of hospitals in terms of mortality, morbidity, and recidivism cannot be related directly to quality of care.

First of all, hospitals differ in the facilities and services they offer to patients. Some have emergency rooms, intensive care units, outpatient units, etc., while others have none of these facilities. This complicates the comparative process, for the hospital with an intensive-care unit may receive many victims of accidents, heart attacks, etc., and consequently show a high mortality rate.

A second consideration implicit here is that hospitals are likely to develop exchanges of patients. The consequence of this is that one partner in such an exchange relationship may appear to obtain better results in its treatment of patients, but this is only because difficult cases are sent elsewhere.

Third, it is clear that medical science has made great advances

[2]Here efficiency is only being considered in terms of process. Ultimately it is felt a single index which considers both quality and process efficiency must be developed. Understanding how various organizational factors are related to both process efficiency and effectiveness is viewed as a first and necessary step in the development of such an index.

in the knowledge and technology used for diagnosing and treating disease, yet hospitals differ widely in the extent to which they have incorporated these new techniques into patient care. Acquisition of these techniques may alter the clientele of the hospital considerably, possibly increasing or decreasing the numbers of patients with serious illnesses.

An alternative to direct, comparative measurement of quality and, we believe, at the present a more viable strategy is to develop a set of criteria for an "effective" hospital. By an effective hospital, we mean one which has the ability to deliver high-quality patient care. Once variability in effectiveness has been specified, factors which help explain it can be isolated and anlyzed.

In attempting to provide a proxy measure or indicator of quality of care to meet our definition, we have developed a scale of institutional adoption of specific innovations in modern medical technology rated by a panel of experts as important for high-quality medical care within a defined area.[3] We have labeled this scale "adoption."

The fact that a hospital can treat the whole patient means that, in general, patients do not have to be transferred in order to receive emergency treatment and that facilities are available for handling complications associated with a particular disease; this appears to be fundamental to the concept of an effective hospital. Similarly, a hospital that lacks medical innovations deemed important by medical experts simply cannot deliver high-quality (i.e., effective) care by current standards.[4] Finally, because medical care involves economic goods or scarce resources, cost inefficiencies may function to deny services to those who need them and hence limit a hospital's effectiveness.

It is recognized that availability of technology is no insurance that it will be properly employed. However, without appropriate technology the potential quality of care delivered is likely to be at a lower level.

[3]We recognize this measure may not be appropriate for use with hospitals individually in determining effectiveness. However, we feel it does have validity on an aggregate analysis basis.

[4]These statements are made with reference to medical technology basic to the normal practice of medicine in a hospital and not with regard to technology required for the diagnosis and management of esoteric diseases which present themselves far less frequently.

Efficiency of Operation

While there are few who would disagree with the idea that all hospitals should have up-to-date facilities and deliver a high quality of medical care, economic realities of the nation's health care system necessitate considering quality of care in relation to efficiency of hospital operations. Given cost constraints, from a policy perspective the question becomes how to provide modern technology at the lowest possible cost. Before proceeding, it is important to explicate clearly the term "efficiency."

In asking how efficient a hospital is, three different and distinct questions are really being raised:

1. To what extent is the hospital utilizing the capacity of its *physical plant?*
2. How much *time* does it take to process a patient?
3. How much *money* does it cost to process a patient?

An indication of the extent to which a hospital is utilizing its physical plant can be inferred from its occupancy rate. A hospital's occupancy rate may be affected by a number of factors (Rafferty, 1971; Ingbar and Taylor, 1968; Lave and Lave, 1970a). But given that an unoccupied hospital bed producing no revenue costs about three fourths as much to maintain as one which is filled, underutilization of a facility clearly results in diseconomies (Lave and Lave, 1970a; Feldstein, 1961). These diseconomies must eventually be borne by the patient and third-party payers.

The second question is directed at the time dimensions of efficiency, a sense of which can be gained by calculating the average length of stay for a hospital's patients. Once again, it must be recognized that a number of factors not controlled for, particularly a hospital's case mix, may play a significant part in determining a hospital's average length of stay. Still, how long a patient remains in the hospital is not wholly determined on the basis of medical exigencies and thus is amenable to being affected by administrative as opposed to purely medical decisions. One example is the informal practice of some hospitals of holding patients over to reduce the likelihood of malpractice suits.

A third question raised deals with the expenses incurred by a hospital to process patients. How much a hospital expends to process a patient is a highly significant question—much more easily asked than answered. The difficulties stem basically from whether expenses should be measured in terms of admissions or patient days. Conceptually, using either unit of analysis would entail mak-

ing a series of erroneous assumptions noted by Lave and Lave (1970b:295). Though seemingly an unlikely choice, the total expenses of a hospital were chosen to measure the monetary dimensions of efficiency. The rationale for using total expenses and the method of calculation are discussed in a later section of the paper.

Keeping in mind how quality of care (adoption) and efficiency have been conceptualized, the next thing to consider is how organizational factors affect both quality and efficiency. It is to this matter the paper now turns.

Organizational Variables

Centralization/Decentralization

We believe that certain organizational factors affect both adoption and efficiency. Our perspective derives from the work of Becker and Gordon (1966) who postulate that formal organizations are developed to coordinate scarce resources to achieve given goals in as efficient a manner as possible. Coordination, however, limits the organization's ability to change. All organizations thus face a dilemma posed by the desire to maximize the benefits of coordination and the necessity for change in response to environmental demands. According to this perspective, the best organizational structure reflects a balance between the gains to be accrued from coordination and the need to adjust to environmental changes. The general premise is that the lower the level within an organization at which procedures are specified, the less requirements for coordination inhibit organizational change.

For example, in assembly-line manufacturing, specified procedures are spelled out to determine the flow of resources from the time the raw materials enter the plant gate to the end of the assemblage process. The end product (e.g., in automobile production) is highly standardized, with limits placed on the variation allowed to meet unique demand requirements. Highly coordinated centralized authority structures are postulated as most effective when external conditions are relatively stable and uniform.

Most organizations, however, deal with heterogeneous environments. Often, as a means of handling diverse environments, multiple authority structures will be established within the same organization. The occurrence of units with different authority patterns within the same organization can best be understood in terms

of what we have referred to as the organizational dilemma: the desire to maximize the gains of coordination and yet respond to environmental demands. One way to resolve this dilemma is to divide the organization into component elements, some with centralized authority patterns facilitating coordination and others with decentralized authority patterns responsive to change.

Hospitals are prime examples of organizations with multiple organizational structures. Characteristically the administrative group in a hospital operates under a different authority pattern from the doctors: the administrators have an executive authority pattern while the doctors operate on a collegial basis with some degree of unit autonomy. By decentralizing decision making in the larger organization to smaller semi-autonomous units, each having responsibility for dealing with a limited sector of the environment, coordination can be accomplished with fewer hierarchical levels. This not only reduces the number of hierarchical levels that must decide upon change but permits independent unit change.

As with all administrative structures, advantages gained in one area incur costs in other areas. Decentralization through the development of semi-autonomous units leads to duplication of administrative functions, difficulties in over-all coordination, and limits economies of scale. On the other hand, decentralization facilitates resource change—that is, the introduction of new and different resources into the organization.

Thus, if the board of directors of a hospital retains most decision-making prerogatives over resource allocation (indicating a centralized structure), the benefits of coordination would be maximized. On the other hand, to permit maximal response and resource flexibility, a hospital would decentralize decision making down to the lowest possible level. However, for most organizations, moving to either extreme compromises overall ability to perform.

This has specific bearing on the question of the impact of organizational structure on adoption and cost. Adoption reflects the ability of an organization to change. But if the ability to change is associated with a lack of coordination in areas in which such coordination is desirable, costs associated with change will be high.

Visibility of Consequences

Given these assumptions, the fundamental question is what factors tend to lead to a hospital structure with a balance between coordination and responsiveness to change? One of the most im-

portant factors affecting organizational structure is the basis upon which decisions are made. The assumption underlying this postulate is quite simple, namely that knowledge of cause and effect in terms of goal attainment (e.g., quality of care) leads to the selection of organizational practices that facilitate goal achievement at lowest costs. Going one step further, it is predicted that in the absence of knowledge about goal-related cause and effect, organizational structure will reflect whatever criteria are used to assess performance. Often, where information regarding goal performance is lacking, the organization assesses performance in terms of relative costs (Thompson, 1967).

Visibility of consequences is considered to range from highly visible, where an organization gathers information on the results of its past performance, to low visibility, where it is not possible or no information on performance is gathered. In the case of hospitals, it is useful to distinguish between two different types of visibility, one related to medical consequences, the other to economic consequences of the hospital's behavior. The sheer presence of either type of information would not be expected to have a direct relation with either a hospital's level of adoption, or its efficiency, since information in and of itself is assumed to have little or no impact until acted upon. The relation of centralization of resource decision making to a hospital's level of adoption and efficiency is expected to be affected by the type and level of information available upon which to base decisions.

Data Base

To collect data to test the relationship between cost and adoption as well as other organizational variables, a random sample of 1,021 hospitals was drawn from the population of United States hospitals for detailed study. Separate questions were sent to each hospital's chief administrative officer and medical officer.[5] Sixty-seven per-

[5]This not only enabled us to obtain a wide range of information but also provided two sources of data on which to base an analysis of the reliability of the instruments. Although space limitations preclude a delineation of our reliability analyses, we can say that, for each hospital, the amount of agreement between the medical officers, the administrative officers, and, for the intensively studied hospitals, our field site researcher, was high. For the questions concerning the presence or absence of each technological item within the hospital, for example, the medical and administrative officers agreed 75 percent of the time. Furthermore, for these items, the administrative officer agreed with study researchers who performed 17 intensive case studies 77 percent of the time and the medical officers agreed with our researchers 79 percent of the time.

cent of the administrative officers ($N = 678$) and 67 percent of the medical officers ($N = 669$) returned the questionnaire. Forty-seven percent of the hospitals returned both questionnaires, and 86 percent responded with at least one of the two instruments.

We also compared our data with the 1968 American Hospital Association annual survey data to determine possible sources of bias. Aside from a tendency for proprietary and federal hospitals to be slightly under- and overrepresented respectively, the two populations appeared similar. In an effort to reduce introduction of factors which might obscure testing the principle thrust of the analysis, the study was limited to a sample of government nonfederal general service hospitals and voluntary general service hospitals. Limiting our frame to these hospitals enables us to perform our analysis in the context of hospitals with similar functions. The primary function of these hospitals is to treat a wide range of diseases without limitations due to profit motive or social characteristics of the patient. Since voluntary and government nonfederal general service hospitals account for 60 percent of the hospitals in the United States, to a large degree generalizability is not compromised. Limiting our analysis to these classes of general service hospitals leaves us with a sample of 388 hospitals.

Operationalization of Variables

In selecting a measure of adoption it was decided, for purposes of comparison, to concentrate on a limited area of medical care. The criteria in selecting the area for study were:

a. That the medical area be relatively broad and relevant to the over-all quality of medical care provided in a hospital;
b. That the area be one where significant progress has occurred, but where serious problems remain;
c. That the innovations in the area reflect many different aspects of medical technology (e.g., drugs, equipment, operating procedures);
d. That the area include a large group of medical experts competent to evaluate the innovations.

The area selected was respiratory disease. Modern technology in this area seemed sufficient to provide a general measure of technological innovativeness. Besides occurring fairly frequently, respiratory disease often complicates other illnesses. Furthermore,

respiratory technology is very often applied in anesthesiology and in postoperative-care illnesses entirely unrelated to respiratory disease itself. It was felt that the ubiquitous nature of respiratory disease technology in health care delivery made it an appropriate focus for study.

To measure the level of adoption of a hospital, a scale was constructed by counting the number of items from a list of twelve innovations[6] each hospital reported having purchased, leased, or rented. The scale constructed can take on values ranging from "0" (no adoption) to "12" (high adoption).[7]

The three dimensions of efficiency are measured using data taken from the 1968 American Hospital Association annual survey. The dimensions of physical plant utilization and time are operationally defined in terms of average occupancy rate and average length of stay respectively. Directly measuring the third dimension, expenses incurred to process patients, gives rise to some conceptual difficulties as previously discussed. An indirect indication of hospital expenses, however, can be constructed. It was reasoned that a hospital's total expenses are affected by both the number of patients it admits and its number of patient days. In turn, both of these factors should be a function of hospital bed size. Analysis of the data showed that size was correlated + .98 with number of ad-

[6]In order to identify technological innovations in this disease area, Dr. Robert Anderson, then Medical Director of the American Thoracic Society, and Dr. Lewis B. Clayton, Director of Medical Statistics for the National Tuberculosis Association, selected from the ranks of the American Thoracic Society 75 physicians who were thought to be experts on respiratory disease. The experts were split into two panels, one to generate a list of technical innovations, the other to rate these innovations in terms of various criteria including the initial and current importance of the innovation for diagnosis and treatment. From the initial list generated of over 200 ideas and discoveries, 12 items were selected for study. Many factors, such as importance, availability of records, and risk, influenced the selection of the 12 items. In each case, however, the items selected were rated to be of at least some importance for the diagnosis or treatment of respiratory disease. An additive index, we felt, was justifiable in this case because the items form a Guttman Scale.

[7]The items selected for inclusion were: Macroaggregated^{131}, Venti Mask, Blood Gas Electrode, Esophageal Balloon, Plethsmograph, Spirometer, Ethambutol, Nacetylysteine, Ultrasonic Nebulizer, IPPB Unit, Mediastinoscope, and LDH Determination. For the sample the 12 form a Guttman Scale with a coefficient of reproducibility of .92.

missions and + .95 with number of patient days. The high correlation with size means that if the effects of size were controlled for in the data analysis, variation in the hospital's total expenses attributable to its number of admissions and patient days would also be controlled for. This is done for the analysis presented by mathematically regressing each independent variable on the variable bed size and extracting the residual for each independent variable. Hence, it should be noted that in the presentation of findings, the independent variables will all be residuals of the variable size. The mathematical treatment of the measure results in it being independent of size and, therefore, analogous to hospital expenses per bed.

Measures of the extent of centralization-decentralization and visibility of consequences were derived from responses to the questionnaires sent to the chief of medicine and hospital administrator.

The survey questionnaire sent to each hospital included an item designed to determine the locus of discretion for five representative resource allocation decisions. To build an index of centralization/decentralization, the responses given for each of the five decisions were coded to reflect the relative frequency with which each decision was made by the board of the hospital, the chief subunit officer (hospital administrator or chief of medicine), or lower levels of the medical staff. Responses were combined to provide an over-all measure of the number of decisions made at each of the three organizational levels. The final measure constitutes an index ranging from "0" (decentralized) to "10" (centralized) which is taken as an indicator of the extent to which the locus of resource allocation decision making is predominantly situated at the board level, the chief officer level, or at the level of the medical staff.

The index of visibility of medical consequences is based on four factors: a hospital's autopsy rate, the number of times a year a hospital's credentials committee met, the percentage of time the chief of medicine devoted himself to the administration of the medical staff, and the percentage of time the hospital administrator devoted to administration of the medical staff. The index of medical visibility was constructed by first ipsitizing the responses to correct for response set. The standardized responses were then weighted by their respective factor loadings generated by a principal components analysis and summed for each hospital.

The index of economic visibility was built by summing the numerical responses hospitals made to two questions regarding the

extent to which the governing body of the hospital was actually involved in decisions about how money is to be spent (i.e., specifications of budget categories) and examination of expenditures within budget categories.

Other Factors Included for Analysis

Although the primary thrust of this study focuses on the impact of centralization-decentralization and visibility of consequences on hospital adoption behavior and efficiency, a series of other factors felt likely to affect either adoption behavior or efficiency was introduced into the analysis as control variables. The series of factors includes: demographic (rural-urban) location of hospital, affiliation with medical schools, presence of outside funds for research, number of full-time non-medical personnel, number of full-time physicians, and number of services available in the hospital. Since, however, a multiple-regression technique will be employed in analyzing the data, an advantage is gained in that any control variable can also be examined in terms of its independent impact on the dependent variables.

The Relationship Between Efficiency and Adoption

As a first step in understanding the impact of organizational structures on efficiency and adoption, it is essential to examine the nature of the relationship between the three measures of efficiency and adoption. From the statements made in the introduction to the paper, two contradictory hypotheses may be advanced:

1. Modern technology is expensive and increases the costs of care in an absolute sense.
2. The costs associated with adoption of modern technology are more than offset by the savings resulting from higher-quality (i.e., more efficient) treatment associated with such technology.

If the first hypothesis is correct, we would expect costs of processing a patient to increase with adoption. A finding that adoption is associated with lower costs would not, in and of itself, indicate that the costs associated with adoption are offset by an increase in efficiency. However, if such a decrease were associated with a reduc-

TABLE 1
Zero-Order Correlations Between Adoption and Three Measures of Efficiency

Total expenses (per bed)[a]	.18[b]
Average length of stay	−.12[b]
Average occupancy rate	.04

a Each variable is a residual of the variable bed size
b $<.05$

tion of time spent in a hospital, support would increase for the second hypothesis. If, in addition, the occupancy rate were found to be associated with adoption, there would be some indication that where choice is possible the medical profession is channeling its patients to what it feels are better hospitals. Controlling for bed size, the following zero-order correlations were found:

Although the relationships are not large, the findings provide support for both hypotheses—there is a relationship between cost and adoption, but there is also support for the effectiveness hypothesis. The smallness of the relationship and its contradictory nature leads one to suspect that other factors may be affecting the efficiency/adoption relationships.

Centralization, Adoption, and Efficiency

Following from the "organization dilemma" discussed earlier, decentralization of decision making was associated with adoption and increased effectiveness, and centralization with increased efficiency. Thus, two hypotheses are posited:

1. The less centralized a hospital's decision-making structure, the greater its rate of adoption of medical technology.
2. The more centralized a hospital's decision-making authority structure, the more efficient it will be in its health care delivery as measured by average length of stay, average occupancy rate, and total expenses.

To investigate the impacts of centralization on adoption and the three measures of efficiency, a series of multiple regressions was

TABLE 2
Regression Estimates of the Impact of Centralization and Other Organizational Factors on Adoption

Explanatory Variables	*Adoption* [a]
Centralization of decision making	−.13[b]
Urban/rural (urban = 1, rural = 0)	.36[b]
Hospital affiliated with medical school	.08
Years since founding	.09
Outside funds for research	.26[b]
Other assets	−.09
Number of full-time physicians	−.01
Number of different specialists on staff	+.06
Number of full-time non-medical personnel	−.02
Number of services	.07
Visibility of economic consequence	.00
Visibility of medical consequence	−.07

$MR = .64$ $N = 388$.
[a] Values reported are Beta weight.
[b] Beta greater than twice its standard error, significant at .05 level.

performed. Turning to the data presented in Tables 2-5, it is seen that when the direct effect of centralization is taken into account, hospitals which adopt more modern technology have higher occupancy rates, lower average lengths of stay, and no higher level of total expenses. Table 2 presents the results of the multiple regression of adoption on a series of variables. The negative Beta = − .13 supports the hypothesis that centralization of decision making has an inverse effect on a hospital's level of adoption. This finding supports the proposition that concentration of decision making, with regard to resource allocation, tends to result in the hospital's incorporating fewer advances in medical technology. Conversely, when the discretion to make resource decisions is held by members of the medical staff, the hospital is more likely to acquire technological advances in medicine and thus have more up-to-date medical facilities.[8] If, as stated earlier, having a modern medical facility is a prerequisite to delivery of a high quality of medical care, then the data suggest that consideration be given to developing mechanisms which increase physician participation in the resource allocation decisions of hospitals. The positive and negative consequences which might arise as a result of involving

[8]In the 10 percent of hospitals where the hospital administrator is a physician, it is expected that the impact of centralization on adoption would be modified.

TABLE 3
Regression Estimates of the Impact of Centralization and Other Organizational Variables on Occupancy Rate

Explanatory Variables	*Average Occupancy Rate* [a]
Centralization of decision making	−.10[b]
Adoption	.13[b]
Urban/rural (urban = 1, rural = 0)	.10[b]
Delay in admission	.34[b]
Hospital affiliation with medical school	.05
Other assets	−.04
Number of full-time physicians	.00
Number of different medical specialists on staff	.06
Number of full-time non-medical personnel	.02
Number of services	−.04
Visibility of economic consequence	−.01
Visibility of medical consequence	−.14[b]

$MR = .46$ $N = 388$.
[a] Values reported are Beta weight.
[b] Beta greater than twice its standard error, significant at .05 level.

physicians in the process of resource allocation decisions are important considerations worthy of empirical study.

Given the second hypothesis, though, an equally critical problem is posed: what happens to the level of efficiency with which care is delivered if decision making is decentralized? Tables 3, 4, and 5 show the impact of centralization-decentralization and the organizational factors on the three dimensions of efficiency: the average occupancy rate, average length of stay, and total expenses.[9] A hospital's level of adoption is retained in the analyses of efficiency, since interest lies with the impact of centralization on the efficiency with which a hospital processes patients at a given level of quality.

Table 3 shows that centralization of resource decision making has a negative relation (Beta = − 10) to occupancy rate, indicating that utilization of a hospital's physical facilities is not facilitated where decision-making powers rest with the head of the organization, as hypothesized. On the contrary, the data suggest that more

[9]Although our primary theoretical concern is with the effect of centralization on adoption, significant impact of geographic location and outside funds for research can also be seen. Further comment on the independent impact of these factors will be deferred until a later point.

complete use of beds occurs where physicians at the patient-care level are themselves directly involved in the administration of resource allocation decisions in the hospital. Why this is the case is possibly clarified if one notes that the relation of level of adoption to occupancy rate is significant and positive (Beta = .13), keeping in mind that centralization of decision making was found to have a negative relation to adoption. This suggests that hospitals which adopt more medical innovations tend to experience higher rates of utilization of their facilities. A possible explanation for this finding is that hospitals with modern medical facilities are more medically attractive to both patients and physicians and thus experience greater demand for their beds. The plausibility of this explanation is supported in part by the significant relation between delay in admission and occupancy rate (Beta = .34). Thus, contrary to what might have been expected, having modern medical facilities may in fact lead to greater efficiency of health care delivery in terms of the more complete utilization of the facility. The direction of causality could, however, work in the opposite direction. That is, fully utilized hospitals would be more likely to have the resources needed to adopt new medical technology. Obviously, longitudinal data are required to determine directionality. However, regardless of the direction of causality, the analysis suggests that the nature of the association of adoption and occupancy rate does not directly contribute to hospital inefficiency.

It can be seen from Table 4 that centralization does not have a significant impact on a hospital's average length of stay, as hypothesized. Taking account of other variables, whether the owner of the hospital maintains tight control over decisions himself or lets the medical staff make decisions has little impact on expediting the process of treating patients. As was the case in Table 3, however, a hospital's level of adoption does appear to bear significantly on the average time it takes to treat a patient (Beta = −.11). To the extent that a hospital's level of adoption can be taken as an indicator of the hospital's over-all ability to provide modern medical facilities, the data suggest that adoption contributes to efficiency by reducing the average length of time taken to treat patients.

Of further interest, it is noted from Table 4 that while the number of non-medical personnel (presumably available to treat patients) appears to have the effect of reducing average length of stay (Beta = − .14), the magnitude of a hospital's outside funds for research (Beta = .10) and its number of full-time attending physi-

TABLE 4
Regression Estimates of the Impact of Centralization and Other Organizational Factors on Average Length of Stay

Explanatory Variable	*Average Length of Stay* [a]
Centralization of decision making	.05
Adoption	−.11[b]
Urban/rural (urban = 1, rural = 0)	.01
Delay in admission	.01
Hospital affiliated with medical school	.01
Outside funds for research	.10[b]
Other assets	.00
Number of full-time physicians	.18[b]
Number of different medical specialists on staff	−.06
Number of full-time non-medical personnel	−.14[b]
Number of services	−.03
Visibility of economic consequence	.05
Visibility of medical consequence	−.02

$MR = .29$ $N = 388$.
[a] Values reported are Beta weight.
[b] Beta greater than twice its standard error, significant at .05 level.

cians (Beta = .18) are related to an increasing average length of stay. These fundings raise the question of whether teaching hospitals, which normally have both large numbers of full-time attending physicians and large quantities of outside research funds, tend to keep patients for longer periods of time. It would be of interest to examine the implications of these findings with regard to the relation between the quality of patient care received and the use of patients for teaching purposes in such hospitals.

Finally, Table 5 shows that centralization of decision making appears to have an inverse effect on a hospital's total expenses (Beta = − .08), as predicted.[10] If the causal sequence is as predicted, in terms of monetary dimension of efficiency, this means that greater cost savings are realized by hospitals which have resource decision-making authority vested at the top than in hospitals

[10]The reader is reminded that by using variables in the analysis where the effect of hospital bed size, total number of admissions, and total number of patient days have been controlled for, the variable "total expenses" can be taken as a measure of expenses per bed.

TABLE 5
Regression Estimates of the Impact of Centralization and Other Organizational Factors on Total Expenses

Explanatory Variables	*Total Expenses* [a]
Centralization of decision making	−.08[b]
Adoption	.03
Urban/rural (urban = 1, rural = 0)	.27[b]
Cost of manpower	.03
Delay in admission	.17[b]
Hospital affiliated with medical school	.14[b]
Years since founded	.16
Outside funds for research	.33[b]
Average occupancy rate	.03
Average length of stay	.08[b]
Other assets	.04
Total visits—outpatient services	.03
Number of full-time physicians	−.04
Number of different medical specialists on staff	−.16[b]
Number of full-time non-medical personnel	.18[b]
Number of services	−.09[b]
Visibility of economic consequence	−.05
Visibility of medical consequence	−.03

$MR = .81$ $N = 388$.
[a] Values reported are Beta weight.
[b] Beta greater than twice its standard error, significant at the .05 level.

where responsibility for resource allocation decisions lies with the medical staff.

Further, it is seen from Table 5 that a hospital's level of adoption does not, as is often assumed, appear to exert any influence on total expenses.[11] Care must be taken, however, in interpreting this finding. It would be in error to conclude from this that the costs of operating a modern medical facility are not increased, particularly where, in conjunction with adoption of a new innovation, a hospital must hire technical support personnel to operate it. Analysis by Andersen and May (1972) of factors contributing to increasing costs of hospital care strongly suggests that increased labor costs are a major cause of rising hospital expenses. Looking at the impact of the number of full-time non-medical personnel on total expenses (Beta = .18) would appear to support such a contention. For this argu-

[11] Since staff size is an independent variable in our multiple regression, the effect of adoption on total expenses is independent of its contribution to increases in staff size.

ment to hold, though, there would have to be a strong relation between level of adoption and number of full-time non-medical personnel. The correlation between adoption and number of full-time non-medical personnel, however, is only $r = .03$ (data not shown), suggesting that the relation between adoption of medical technology, labor costs, and total expenses is much more complex than previously conceived of in the literature. Insight into the nature of this series of relationships will be presented in Table 9.

Total expenses, however, are only one way of looking at monetary efficiency. As has already been reported in Tables 2 and 3, hospitals with high adoption rates have a shorter average length of stay and a higher occupancy rate. Thus, while the technologically modern hospital may have higher costs per patient day, it processes more patients in fewer days, with the result that the cost per patient stay may be lower for higher-quality care.

Thus, from Tables 2-5 it is seen that while the impact of centralization-decentralization of resource decision making on a hospital's level of adoption is as was predicted, its impact on efficiency is not as clear. It was hypothesized that centralization would facilitate efficiency of health care delivery, but this appears to be the case only with regard to total expenses. In terms of the time it takes the hospital to process patients, it seems to make little difference at which level resource allocation decisions are made in the organization. On the other hand, hospitals with decentralized decision-making authority do show a higher rate of utilization of bed capacity. Taken together, these findings emphasize the underlying complexity of factors which must be understood in order to deal with the problems of increasing hospitals' efficiency of health care delivery.

Further, in Table 5 it can be seen that geographical location (urban), delay in admissions, affiliation with a medical school, age of facility, amount of outside funds for research, average length of stay, and number of full-time non-medical personnel all contribute to higher total expenses for hospitals. However, as will be seen shortly, the impact of some of these factors is variable when the availability of information to decision makers (as measured by visibility of consequences) is taken into account.

Having examined the effect of who in the hospital makes decisions (centralization), the next question to raise is how the presence or lack of information (medical/economic visibility of consequences) concerning the organization's activities modifies the

impact of adoption on efficiency under varying degrees of centralization-decentralization of decision-making authority.

The Basis of Decision

The data presented thus far provide support for the contention that who makes decisions in a hospital has differential effects on how well the organization is able to handle the problem of keeping down the cost of care and maintaining up-to-date medical facilities. Following this lead, the next thing asked is whether having available information or knowledge of past consequences on which to base decisions facilitates these trends.

Distinguishing between medical and economic visibility of consequences led to the formulation of two hypotheses:

1. Decentralized hospitals with high visibility of medical consequences would adopt more new medical technology than decentralized hospitals having low medical visibility.
2. Centralized hospitals with high visibility of economic consequences would be more efficient than centralized hospitals with low visibility.

Further, it was expected that the predicted relations between adoption and centralization of resources decision making and the three measures of efficiency and centralization would be enhanced when either type of visibility was high. Operating under conditions of high visibility of either type, it was felt, would have the general effect of facilitating decision makers' awareness of issues, thus enabling them to find ways to improve the hospital's quality of care when resource decision making was decentralized and improve efficiency of delivery when decision making was centralized.

To test the hypotheses, it is necessary to dichotomize hospitals twice: first on the basis of high or low visibility of medical consequences, and second on high or low economic visibility.[12] Tables 6-9 display the results of this analysis.[13]

A comparison of the beta values for centralization across conditions of visibility of consequences in Table 6 indicates two points.

[12]The correlation between economic and medical visibility of consequences is $r = -.05$.

[13]For reasons already explained, the variables used are corrected for hospital bed size.

TABLE 6

Regression Estimates of the Impact of Centralization and Other Organizational Factors on Adoption Controlling for Levels of Economic and Medical Visibility of Consequence

EXPLANATORY VARIABLE	ADOPTION [a]			
	Visibility of Economic Consequence		Visibility of Medical Consequence	
	High	*Low*	*High*	*Low*
Centralization of decision making	−.20[b]	−.11[b]	−.20[b]	−.09[b]
Urban/rural (urban = 1, rural = 0)	.28[b]	.45[b]	.31[b]	.30[b]
Hospital affiliated with medical school	−.03	.16[b]	.05	.09
Outside funds for research	.22[b]	.31[b]	.30[b]	.29[b]
Other assets	−.17[b]	−.02	−.03	−.08
Number of full-time physicians	.20[b]	−.08[b]	.02	−.03
Number of different medical specialists on staff	.02	.09[b]	.14[b]	.03
Number of full-time non-medical personnel	−.16[b]	.01	.09[b]	−.17[b]
Number of services	.10[b]	.06	.07	.02
Visibility of economic consequence			−.09[b]	.03
Visibility of medical consequence	.03	−.13[b]		
MR =	.64	.72	.67	.64
N =	205	170	156	184

[a] Values reported are Beta weight.
[b] Beta greater than twice its standard error, significant at the .05 level.

First, the negative signs of all four beta weights for centralization mean that, regardless of the type or level of visibility of consequences present in a hospital, centralization of resource decision-making authority has a negative relation to a hospital's level of adoption. Conversely, in situations where authority has been delegated to the medical staff, the hospital tends to keep the facility up to date medically. Secondly, the decentralized structure appears to facilitate adoption more when visibility of either medical or economic consequences is high. This finding tends to support the general contention that having information regarding the past performance of the hospital provides a basis for assessing anticipated courses of action and acts as an impetus on decision makers to improve medical performance.

Relevant to the above point are findings from a further analysis done on the same data base (Gordon, Tanon, and Morse, 1974). There hospitals were categorized into one of four groups on the basis of whether they exhibited high or low economic and medical visibility of consequences. A comparison of the mean level of adoption of each group supported the prediction that hospitals having a high level of medical visibility and a low level of economic visibility would adopt more medical innovations ($\bar{X} = 5.9$) than hospitals having high economic visibility and low medical visibility ($\bar{X} = 4.5$).

Returning to the present analysis, however, a more complex picture emerges when the direct effects of economic and medical visibility of consequences are examined. Under the condition of low economic visibility of consequences, the higher the level of medical visibility the lower the level of adoption (Beta $= -.13$). Similarly, under conditions of high visibility of medical consequences, the higher the level of economic visibility the lower the adoption. Further examination of the impact of other variables indicates that geographic location (urban) and amount of outside research funding have the most significant and consistent impacts on adoption. The differential impact of the number of full-time physicians and number of full-time non-medical personnel under different types and levels of visibility of consequences is a further indication of the complex relationship among information, structure, and adoption. The interrelationship among these variables clearly indicates that further research is warranted in this area.

Turning to the impact of centralization on efficiency, for occupancy rate, under all conditions of visibility (Table 7), the negative beta weights suggest that centralized decision making is associated with underutilization of a hospital's bed capacity.

TABLE 7

Regression Estimates of the Impact of Centralization and Other Organizational Factors on Average Occupancy Rate Controlling for Levels of Economic and Medical Visibility of Consequence

EXPLANATORY VARIABLE	AVERAGE OCCUPANCY RATE [a]			
	Visibility of Economic Consequence		Visibility of Medical Consequence	
	High	*Low*	*High*	*Low*
Centralization of decision making	−.10	−.17[b]	−.11[b]	−.04
Adoption	.08	.20	.05	.16[b]
Urban/rural (urban = 1, rural = 0)	.07	.12[b]	.07	.10
Delay in admission	.40[b]	.28[b]	.40[b]	.30[b]
Hospital affiliated with medical school	.01	.09	.03	.05
Other assets	−.07	−.02	.01	−.16[b]
Number of full-time physicians	.01	.03	.00	−.03
Number of different medical specialists on staff	.03	.07	.11[b]	.06
Number of full-time non-medical personnel	.00	.03	.02	.08
Number of services	.01	−.13[b]	−.06	−.06
Visibility of economic consequence			+.01	−.13
Visibility of medical consequence	−.05	−.26[b]		
MR =	.47	.52	.53	.45
N =	205	170	156	184

[a] Values reported are Beta weights.
[b] Beta greater than twice its standard error, significant at the .05 level.

Further, this tendency is facilitated somewhat when the staff is operating in a situation where medical performance is being evaluated (high medical V of C) (Beta = − .11) or when the governing body of the hospital is not as cognizant of the hospital's economic circumstances (low economic V of C) (Beta = − .17). These patterns in the data suggest, contrary to the hypothesis, that allowing physicians more freedom in and responsibility for determining how and when to utilize the bed capacity of the hospital facilitates use of the physical plant.

Looking at the direct effect of adoption on average occupancy rate under different types and levels of visibility of consequences, it appears that adoption only has a positive influence when either economic or medical visibility is low. It also seems apparent from looking at the other variables in Table 7 that a hospital's delay in admission is most directly interrelated with its occupancy rate.

Table 8 shows the relation of centralization and other factors to the second dimension of efficiency, average length of patient stay. It was predicted that under the condition of high visibility of economic consequences, centralization would have a significant influence on reducing patients' average length of stay. The exact opposite is evidenced in the data.

The importance of introducing the factor of visibility of consequences into the analysis is made particularly evident in this instance. The reader will recall that Table 4 indicated that who made decisions had no significant impact on a hospital's average length-of-stay statistics. However, a very different conclusion is drawn when comparing the relation of who makes decisions under conditions of high and low economic visibility to average length of stay. Centralization of authority has the impact (Beta = .08) of increasing the average length of stay when visibility is high. There is a suggestion in the data, although not significant (Beta = − .07), that centralization only facilitates a lower average length of stay where awareness of the hospital's economic state is low. Why might this be the case?

The measure of economic visibility, it will be recalled, is based on the extent to which the governing body of the hospital participates in the budget allocation and review processes. Given this fact, the data indicate that if persons at the top of the organization retain administrative control over the hospital's activities, they are more apt to establish procedures and follow courses of action which give priority to economic rather than medical considerations when they are cognizant of the economic state of the system

TABLE 8

Regression Estimates of the Impact of Centralization and Other Organizational Factors on Average Length of Stay Controlling for Levels of Economic and Medical Visibility of Consequence

EXPLANATORY VARIABLE	AVERAGE LENGTH OF STAY [a]			
	Visibility of Economic Consequence		Visibility of Medical Consequence	
	High	*Low*	*High*	*Low*
Centralization of decision making	.08[b]	−.07	.03	.08
Adoption	−.12[b]	−.13[b]	−.12[b]	−.07
Urban/rural (urban = 1, rural = 0)	−.02	.09	.08	.02
Delay in admission	−.02	.08	.06	−.04
Hospital affiliated with medical school	−.02	.06	.06	−.10[b]
Outside funds for research	.13[b]	.07	.13[b]	.20[b]
Other assets	−.02	.04	.02	−.05
Number of full-time physicians	.22[b]	.24[b]	.21[b]	.18[b]
Number of different medical specialists on staff	−.04	−.10[b]	−.08	−.15[b]
Number of full-time non-medical personnel	−.21[b]	−.13[b]	−.11[b]	−.17[b]
Number of services	−.02	−.07	−.04	.03
Visibility of economic consequence			−.04	.05
Visibility of medical consequence	−.03	−.06		
MR =	.33	.39	.40	.33
N =	205	170	156	184

[a] Values reported are Beta weight.
[b] Beta greater than twice its standard error, significant at the .05 level.

than when they are not. This is not meant to imply that in such instances persons intentionally made decisions disregarding the medical needs of the hospital's patients. However, the economic realities of delivery of hospital care, if given priority over medical considerations, are less likely to result in decisions favorable to the patient.

For the most part, hospitals follow a policy of billing patients a fixed charge per day, regardless of how many days they remain in the hospital. In reality, though, a hospital incurs more expenses to process a patient at the time of admission and for a period thereafter than it charges the patient. As the patient stays longer, however, the price charged exceeds the expenses of services delivered, enabling the hospital to recover its costs. Thus as it now stands, given the billing policies which hospitals must presently follow if they are to be reimbursed by the major third-party payers, the economically aware rational head is likely to favor decisions which extend or do not reduce the average length of time a patient stays in the hospital.

A change in the present nationwide billing policy to allow hospitals to charge patients on the basis of a decreasing sliding scale would reduce or eliminate the economic constraints now operating and thus encourage hospitals to keep patients for a shorter period of time. Though such a policy would not presumably reduce the total charged a patient, by lowering the hospital's average length of stay, a hospital would be able to serve more patients with the same number of beds. Given the expanding demand for hospital inpatient care and the high cost of building new bed facilities, such a change seems warranted.

Returning to Table 8, it may be seen that, as was the case in Table 4, the number of non-medical personnel has the effect of reducing average length of stay, whereas the magnitude of a hospital's outside research funds and its number of full-time attending physicians have the effect of increasing average length of stay. It would appear then that the trends previously discussed remain even under different conditions of visibility of consequences.

The final dimension of efficiency considered, total expenses (Table 9), is seen to be inversely influenced by centralization under all four types and levels of visibility of consequences. Looking at the impact of other factors, it can be seen that geographic location, the time since the hospital was founded, and amount of outside research funds all have a positive impact on a hospital's total ex-

penses. Adoption of medical technology has a differential impact on total expenses, depending upon the nature of a hospital's visibility of consequences. Under conditions of low economic visibility or high medical visibility, adoption has a positive impact on total expenses; but when economic visibility is high or medical visibility is low, a hospital's level of adoption has no effect. The interrelationship between types and levels of visibility of consequences as they impinge upon the impact of adoption on total expenses warrants further investigation. In line with this, there are several other indications from the data in Table 9 of the differential impact of various organizational factors on total expenses under varying conditions of availability and use of information in the hospital (i.e., visibility of consequences). For example, with high visibility of economic consequences, the greater the number of full-time nonmedical personnel the lower the total expenses. However, the reverse is true under conditions of low economic or high medical visibility of consequences. Thus, in reference to the previous discussion of the relation among level of adoption, labor, and total expenses, it can be seen that whether labor has an impact on total expenses depends upon the nature of the organization's information system. Similarly, where visibility of economic consequences is low, medical school affiliation has a positive relation to total expenses, whereas when economic visibility is high, such an affiliation appears to have no effect on total expenses. Interestingly, with high visibility of medical consequences, the use of outpatient services has a positive relation to total expenses but holds no relation under other conditions of visibility.

Looking at the effects of economic visibility of consequences itself on total expenses, only when visibility of medical consequences is low does it have a negative effect. On the other hand, there is no effect of visibility of medical consequences on total expenses under either level of visibility of economic consequences. These findings raise the serious question of the circumstances under which various medical and economic information systems contribute to improved performance of the hospital.

To a large extent, information regarding past performance can be thought of as value-free. While it can form the basis of a series of decisions, it does not determine the nature of the decisions themselves. Today, top officials of hospitals face myriad pressures from the public and private sectors of society to keep costs down. Thus it is understandable that their decisions would reflect a

TABLE 9

Regression Estimates of the Impact of Centralization and Other Organizational Factors on Total Expenses Controlling for Levels of Economic and Medical Visibility of Consequence

EXPLANATORY VARIABLE	TOTAL EXPENSES [a]			
	Visibility of Economic Consequence		Visibility of Medical Consequence	
	High	*Low*	*High*	*Low*
Centralization of decision making	−.13[b]	−.14[b]	−.21[b]	−.04[b]
Adoption	−.03	.12[b]	.08[b]	−.02
Urban/rural (Urban = 1, rural = 0)	.21[b]	.31[b]	.19[b]	.22[b]
Cost of manpower	.04	.00	.02	.00
Delay in admission	.19[b]	.14[b]	.16[b]	.19[b]
Hospital affiliated with medical school	−.03	.27[b]	.14[b]	.12[b]
Years since founding	.16[b]	.14[b]	.16[b]	.13[b]
Outside funds for research	.43[b]	.28[b]	.32[b]	.37[b]
Average length occupancy rate	.06	−.01	−.07	.06[b]
Average length of stay	.04	.03	.01	.10[b]
Other assets	.13[b]	−.09	.05	.00
Number of full-time physicians	.06	−.05	.04	−.38[b]
Total visits—outpatient services	.06	−.04	.11[b]	.01
Number of different medical specialists on staff	.00	−.32[b]	−.10[b]	−.17[b]
Number of full-time non-medical personnel	−.09[b]	.26[b]	.30[b]	.00
Number of services	−.01	−.16[b]	−.12[b]	−.14[b]
Visibility of economic consequence			.02	−.08[b]
Visibility of medical consequence	.00	−.03		
MR =	.84	.89	.86	.91
N =	205	170	156	184

[a] Values reported are Beta weights.
[b] Beta greater than twice its standard error, significant at the .05 level.

stronger concern for the monetary aspects of health care delivery. On the other hand, physicians are more likely to concern themselves with the quality of care they deliver to their patients. Thus simply increasing the level of awareness of economic and medical past performance in a hospital as a means of improving the quality and efficiency of health care delivery without concern for who is going to use the information is likely to result in wasted efforts. While this may appear to be a rather obvious point, it is the case that hospitals have in the past and are presently being pressed to institute programs and procedures for evaluating both their economic and medical performance. In at least two instances, findings of this study suggest that information-collecting programs have, as yet, little positive impact on hospital behavior. Specifically, we are referring here to a hospital's accounting system, and second, to whether a hospital participates in the Medical Audit Procedures (M.A.P.) program.

Though developing and maintaining an elaborate accounting system necessarily requires a sizable expenditure of funds, pressure at a national level has been placed on hospitals to improve their accounting practices. One possible rationale behind doing so is that having a sophisticated accounting system will provide a hospital with the kind of financial information needed to effectively control, if not reduce, its costs of delivering care. In a similar vein, encouraging hospitals to utilize the services of M.A.P. can be seen as a way a hospital can gain an increased awareness of its medical staff's performance relative to other hospitals. Conceivably, such information could provide a strong impetus to improve the quality of care they deliver. One indicator of this would be the frequency with which they adopt new medical technology. Since there is a great variation in the sophistication of hospitals' accounting systems, and less than half of them subscribe to M.A.P., it was possible to test whether in fact these two mechanisms for raising levels of visibility were having any effect.

The relation between hospitals' sophistication level of accounting techniques and the three dimensions of efficiency was found to be almost nil. Similarly, whether or not a hospital participated in M.A.P. showed no relation to the frequency with which it adopted new technology.

Hence, using the criteria of increasing efficiency on the one hand or stimulating the adoption of new medical technology on the other, neither of these techniques appears to work. But why

shouldn't they, at least potentially, lead to increased information being available in the organization upon which to base decisions?

The answer may lie with a point raised earlier. Simply increasing the quantity and/or quality of information a hospital has concerning its past performance with regard for who is going to make use of the information may be a fruitless endeavor. Without question, an elaborate accounting system can provide decision makers with a great deal of information, but effective use of it can only be made if a hospital has someone on hand with the expert knowledge of accounting theory to interpret the figures. To the extent that decision makers in the hospital lack such expertise or access to it, a more sophisticated accounting system is only producing information which no one knows how to apply. It might be more judicious in terms of reducing expenses to refrain from pressuring hospitals any further on this front until such time as they are also required to retain on their administrative staffs the experts needed to adequately interpret the information.

Likewise, a hospital which participates in M.A.P. receives aggregated information regarding its past medical performance. While such information could be potentially useful, in the hands of individuals who are not oriented to it and who work in an environment which requires them to deal with one patient at a time, it may have no significant value. It is likely that such information can only be effectively utilized by persons sensitive to the complex issues involved in organizing health care delivery systems. Suffice it to say, it is unlikely physicians in most cases are prepared to use the statistics generated by M.A.P.

To the extent that what has been found in the two instances can be generalized to other mechanisms for generating information in hospitals, it would seem imperative to evaluate more fully the circumstances surrounding the intended use of the information produced before requiring hospitals to invest money and manpower to institute such mechanisms.

Conclusion

As stated in the introduction to the paper, our major concern was with clarifying the effects of various organization factors surrounding the relationship between level of adoption of new medical technology and the costs of hospital services. The data presented

support the contention that who makes decisions in a hospital has a differential effect on how well the organization is able to handle the problem of keeping down the costs of care and maintaining up-to-date medical facilities. Decentralization of decision making appears to facilitate a hospital's adoption of modern medical technology. Conversely, centralization of decision making is associated with lower total expenses. Further, contrary to what is often thought, it was found that a high level of adoption has the effect of reducing average length of stay and increasing average occupancy rate while having little direct impact on a hospital's total expenses. The evidence indicates that in terms of efficiency, organizational structure is an important factor in determining whether gains in effectiveness outweigh expenses associated with the adoption of new technology.[14]

When the level of economic and medical information available (visibility of consequences) in hospitals is taken into consideration, the impact of centralization on adoption behavior and efficiency is found to be far more complex than initially predicted. These findings, in concert with the lack of effect of a hospital's sophistication level of accounting techniques on total expenses and the lack of effect of participation in M.A.P. on adoption behavior, suggest the importance of increasing our understanding of the relationships between information systems, decision making, and organizational structure in hospitals.

[14]While this paper has focused on the impact of internal organizational structure on hospital efficiency and effectiveness, a relatively consistent relation of hospital location (rural-urban) to the dependent variables is also apparent. Though only a global indicator of the nature of a hospital's external environment, the data suggest that a more refined examination of the impact of environmental characteristics on hospital behavior may be fruitful.

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