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RM-6057/1
JANUARY 1970

IMPROVING BUDGETING PROCEDURES
AND OUTPATIENT OPERATIONS
IN NONPROFIT HOSPITALS

Vincent D. Taylor and Joseph P. Newhouse

The RAND Corporation
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This study is presented as a competent treatment of the subject, worthy of publication. The Rand Corporation vouches for the quality of the research, without necessarily endorsing the opinions and conclusions of the authors.

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PREFACE

This Memorandum explains a methodology that is useful in analyzing the operation of private nonprofit hospitals. This methodology was developed as part of a long-term effort to find means of improving hospital organization and operation. It has already proved valuable in analyzing the operation at a number of different institutions.

Meeting the challenges posed by the rapidly increasing costs and sophistication of modern hospital care will require significant changes in the internal organization and operation of hospitals. It may also require rearrangement of the relationships of hospitals with other relevant organizations. Up until now proposed changes and rearrangements have seemingly had little effect. Actual changes have been few, and costs are still rising sharply. Why have the proposed solutions met with such little success? One reason is that little attention has been paid to problems at the level of an individual hospital. Partly because of this, the solutions to hospital problems put forward in the literature often appear unrealistic, impractical, or irrelevant.

We have tried to avoid this pitfall by examining actual problems that troubled management at a particular hospital. To preserve confidentiality, we have called this hospital Westfield Hospital. Although many aspects of Westfield Hospital are unique, we believe that the methodology developed in examining its operations should have wide applicability.

The data attributed to Westfield Hospital are hypothetical and the numbers in the text are therefore only illustrative of figures obtained from the original hospital study. Where it seems useful and appropriate however, we have indicated the qualitative nature of our actual findings.
SUMMARY

This Memorandum analyzes the budget of a nonprofit hospital and the costs and operations of its Outpatient Department (OPD). The problems addressed were raised in a study of a private, nonprofit hospital. The fundamental question asked was: How can a hospital use the funds available to it to provide maximum benefit to the community? Several findings emerged:

(1) The management of the hospital must be aware of all the costs its activities are imposing upon the community and all the benefits it is providing to the community. A useful tool for conveying this information would be a revised budget format. The present budget format at many hospitals is that of a profit-making firm. Such a format focuses upon profit or loss, ignoring benefits provided to the community for no charge (training of medical students, provision of care to indigents) and costs not paid for by the hospital (contributed services). We have designed a revised budget format to correct this.

(2) The revised format emphasizes the subsidy that a hospital provides to the community. Subsidy to the community is defined as the difference between what the community pays for the service at the hospital and what it would pay elsewhere. An appropriate goal for management is to maximize this subsidy, subject to the constraint that the deficit not be larger than a given amount.

(3) At a hospital that has a teaching program, the subsidy obtainable from a given deficit can be subdivided into the subsidy to patient care, to teaching, to research, and to excess costs of operations (inefficiency). We show how to estimate the magnitude of these subsidies for OPD operations. At the hospital studied the subsidy to the teaching program was negative, implying that without the teaching program, costs would be higher than at present.
(4) The subsidy to patient care and its distribution among income and family-size classes have also been considered. The hospital studied followed a policy of charging a uniform price for each outpatient clinic. This had unintended, undesirable effects upon the distribution of the subsidy. Third parties were subsidized, while some individuals paid more than if they saw a private physician. Such effects could be eliminated by charging the market price for the service rather than a uniform price.

(5) The analysis shows how the subsidy to patient care and the deficit are affected by changed levels of operation in the various clinics. In the actual study it was found that the subsidy to patient care could be increased for a given deficit and a given level of other subsidies by expanding most clinics. Alternatively, the deficit in the OPD could be decreased (and used elsewhere in the hospital), while maintaining the present level of subsidy to patient care in the OPD.
ACKNOWLEDGMENTS

The authors would like to express their appreciation for the courtesy and assistance of the staff of Westfield Hospital. Unfortunately they must remain nameless.

We would also like to acknowledge the assistance of our Rand colleagues. James Dei Rossi's collection and analysis of financial data provided a valuable background for the analysis and recommendations presented in this Memorandum. Edward Forgots, Marvin Kosters, and Leland Johnson gave us helpful comments on a draft.

A very special acknowledgment is due Dr. Peter Bing, without whom this study truly would not have been possible. He not only made the arrangements that permitted the study to take place, but his questions and counsel helped to keep the study focused on the real-life problems faced by hospital management.
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I. INTRODUCTION

Most of this Memorandum concerns the analysis of costs and operations of the Outpatient Department (OPD) of a hospital. The analysis is based upon research undertaken at an actual hospital but to preserve confidentiality we have named the hospital Westfield Hospital. Also all data in this Memorandum are hypothetical. The illustrative data are used to clarify the methodology. Where appropriate, however, we have indicated the qualitative results actually found.

It is our hope that the implications of the analysis will extend considerably beyond hospital outpatient departments and, in fact, will be applicable to all hospital operations, as well as to outpatient care provided in settings other than hospitals. The ultimate purpose of this Memorandum is to provide a better understanding of the problems and choices that confront hospital managements and managements at other nonprofit institutions providing medical services. We have focused on the OPD in order to provide a concrete context in which to explore approaches to improving management decisions.

The fundamental problem addressed is, "How can a hospital use the funds that it has available to provide the maximum benefit to the community?" In terms of benefit to the community, a good method for making management decisions is equally important whether an institution is operating at a surplus or a deficit. In terms of the pressures on management, however, the basis for budget decisions becomes much more important when operating at a deficit. If programs must be curtailed, employment reduced, and previously accepted plans revised downward, the importance of having rational grounds for choosing what is to survive the budget-cutting knife is clearly apparent.

The need for improved methods of making hospital budget decisions is currently felt acutely by management at many hospitals because expenses have been increasing rapidly in recent years and revenue sources are unable to keep up. Hence, deficits (even including philanthropic income) have been frequent at many hospitals. Such was the case at Westfield Hospital. Obviously, deficit operations cannot continue
indefinitely without driving the hospital out of business; thus at the time this study was begun, the management at Westfield Hospital was already attempting to find ways to reduce expenses and increase revenue so as to bring the budget in balance. It is not surprising, therefore, that trustees, medical staff members, and members of the administration at Westfield Hospital all felt a strong desire for an improved structure for making budget decisions. The concern at Westfield with reducing the deficit is reflected in the analysis and discussion in the body of the Memorandum, but it is to be stressed that the principles that emerged from the analysis are equally applicable to making decisions on how best to spend surplus funds for the benefit of the community.

RESULTS OF THE STUDY

Our approach to improving management decisions was to develop general rules and principles that could be applied to specific situations at the hospital. As a result, some of the reasoning and analysis presented herein may seem abstract and only vaguely related to the specific problems of the hospital. We wish to emphasize, therefore, that the abstract principles have yielded important, practical results. For example, this Introduction later discusses our approach to measuring efficiency of operation and to valuing the services provided the community. The theoretical concepts discussed there led to an estimate that there were inefficiencies in specific areas of the Outpatient Department large enough to make them high priority areas for management review. These concepts also permitted us to estimate that, on balance, the intern and resident training program lowered costs in the OPD, thus providing information that is pertinent to any consideration of changing the size of the training program. Our examination of the proper way to value output suggested an alternative pricing policy for the OPD that would eliminate the hospital's subsidization of California State welfare programs and bring actual charity allowances into line with stated policy. Application of the principles also yielded recommendations for increasing the scale of operations of specific clinics,
which, if implemented, would permit the value of output to be increased without any increase in deficit.

HOSPITAL GOALS AND ACTIVITIES

Good budget decisions cannot be made without understanding how the activities included in the budget relate to the goals of the institution. Management must know whether dollars spent on one activity are more or less beneficial to the attainment of the hospital goals than dollars spent in other ways. When reducing the deficit, the need is to compare the detrimental impact on the institution's goals of alternative expense-cutting or revenue-raising measures. If management merely cuts expenses or raises prices without regard to their impact on the goals of the institution, it may do far more damage than necessary.

At the broadest level, the goal of any nonprofit hospital is to increase the health and well-being of the people who seek medical service from it. At a more operational level, there are three major types of activities in a teaching hospital that benefit the community: (1) the provision of patient care; (2) medical research; and (3) the education of physicians in intern and residency programs. At Westfield Hospital, patient care activities consume most of the budget. Because of their dominance in the budget, we concentrated on measuring and comparing the costs and benefits of various patient care services. The Memorandum does not compare the desirability of patient care with teaching or research, nor are the benefits of teaching and research compared with each other. Rather, attention is directed towards increasing benefits and reducing deficits deriving from patient care.

Even though teaching and research are not subjected to analysis in this Memorandum, it is necessary to know the cost of these activities in order to determine the cost of patient care. In the OPD at Westfield, research is a sufficiently minor activity so that it does not substantially affect total cost. Teaching, however, constitutes a major activity; thus, the cost of teaching had to be found and subtracted from total costs in order to obtain the cost of patient care. It is not sufficient merely to subtract the wages of interns and
residents. What is needed is an estimate of the net impact of the teaching program on OPD costs, after allowing for the additional costs associated with teaching the interns and residents and giving proper credit for the patient care they provide. A methodology for accomplishing this was devised and applied to the OPD, yielding for the first time an estimate of the influence of teaching activities on the costs of that Department.

EVALUATING PATIENT CARE SERVICES

Westfield Hospital pursues two distinct but related objectives in the area of patient care: First, to make available to the community the largest possible amount of high quality medical services, and second, to provide medical services to those who require them but cannot afford to pay the market price for them. Somewhat different considerations are involved in judging performance with respect to these two objectives but, as will be seen, there are important common elements.

Efficiency

Assuming that the quality of service meets desired standards, one of the most important indicators of performance in the provision of medical services is the efficiency with which these services are produced. The more efficiently the services are produced, the more services can be produced, and so the more value the community receives for its dollar. Thus, the benefit the hospital provides the community by supplying a broad range of medical services is directly related to the efficiency with which it produces them.

The level of efficiency can be judged by comparing the cost of producing a unit of service at the hospital with the prevailing prices for a similar service outside of the hospital. Although some of the patient care services provided by Westfield are unique either in kind or in quality, many of the services, particularly in the OPD, are widely available in its market area. If costs at Westfield are below the market price, Westfield is relatively efficient at producing the
service in question. By obtaining the service at Westfield rather than somewhere else, the community benefits because fewer resources are used to produce medical care and so more are available to produce other goods. Conversely, if costs at Westfield are above the prevailing price, the resources used are increased by purchasing care there.

Patient Subsidy

In terms of a hospital's success as a charitable organization, one of the most important indicators of performance is the amount of subsidy provided to patients served by it. The extent to which the subsidy provided by a hospital lessens the financial burden on a patient is reflected in the difference between what he would pay if he went elsewhere and what he does pay at the hospital in question. The amount of subsidy provided a patient should not be measured by the difference between what it costs the hospital to provide a medical service and what it charges for the service, but rather upon the difference between what the patient pays the hospital and what he would have to pay elsewhere (the market value) for the same service. This latter difference measures the extent to which the hospital has lessened the financial burden on the patient.

We therefore define the subsidy to patient care as the difference between total market value of services dispensed and total patient revenue. The greater this subsidy, the more successfully a hospital is fulfilling the objective of lessening the financial burden of medical care for its patients. The desire to make patient subsidy as large as possible must be tempered by the realization that many actions that increase patient subsidy also increase the deficit of the hospital.

*The indirect costs to the patient of obtaining care, such as his time and travel costs, should be included to make this statement strictly true. In this Memorandum we do not consider ways in which the hospital can economize upon the patient's time or travel costs.
Since there is a limit to the deficit that can be incurred, we suggest that a reasonable goal for a hospital in the area of patient services is to maximize the amount of patient subsidy dispensed, subject to the constraint that its deficit not exceed a certain amount.

This goal directly reflects the importance of obtaining philanthropic contributions, since the amount of patient subsidy that can be dispensed will vary directly with the philanthropic income available to underwrite deficits incurred. Pursuit of this goal will also ensure that efficiency enters into management decisions correctly, since for a given amount of philanthropic income, the subsidy provided will vary directly with the efficiency of producing medical services.

Efficiency is important not just because it lowers costs and saves money but also because it permits the hospital to provide more benefits to the community. To the philanthropist, it means that the money donated to the hospital provides a larger amount of patient subsidy. To the patient it means less expensive medical care, but it should be stressed that efficiency is not equivalent to cheapness. Certain services at a hospital may be of high quality and therefore be high cost services. Improving the efficiency of producing them does not imply lowering their quality in order to save money. Rather, greater efficiency implies producing the same quality service with less manpower and other resources.

Several aspects of the philanthropic subsidization of patient care are not treated thoroughly in this Memorandum. These aspects relate to who receives the subsidy and for what purposes. We do not consider whether community benefit could be increased if the distribution of free service among consumers were changed. Present policies of Westfield Hospital attempt to vary the degree of subsidy with the recipient's ability to pay. Our analysis of the OPD revealed that the actual distribution of subsidies differs from that implied by current policies, a situation for which we suggest a remedy. Beyond that there remains the question of whether current policies are desirable. Formally the hospital maximizes community benefit when it dispenses free service in
such a way that an additional dollar of free service given to any individual will provide the community with the same benefit. In practice this criterion is hard to make operational. The benefit to the community of the free service dollar is comprised of the direct benefit to the individual who receives it plus any benefit to others from his receiving it. There is a presumption that the benefit to others is larger for families of little means; thus a free service policy that increases the amount of subsidy as ability to pay decreases (as current policy does) seems indicated. More than that we do not attempt to say.

We have also assumed that the benefit produced is independent of the service being subsidized. In effect, this means that the benefit to others from an individual's receiving care for a disease is the same for all diseases. Since subsidizing treatment of a crippling condition of a child will probably produce more benefit to others than cosmetic surgery, this assumption is not likely to be fulfilled. We felt however, that it was simplest to make this assumption and then allow management to adjust for any untoward results that might result.

PLAN OF STUDY

The following sections attempt to show how the principles and criteria discussed above can be applied to improve management decisionmaking. Section II presents and discusses a revised budget. It contains budget categories that more appropriately reflect the considerations discussed in the previous section than the categories presently used. The budget is an important document for management; at the present time, managements at many hospitals appear to make some important decisions almost solely on the basis of figures it contains. The revised budget format attempts to provide improved indicators of hospital performance and to focus management attention upon relevant areas.

Section III analyzes the operation of the Outpatient Department. The revised budget provides a context for this analysis, which is directed toward suggesting means of reducing the Outpatient Department deficit with minimum loss in community benefit.
II. A REVISED BUDGET FORMAT FOR THE HOSPITAL

THE HOSPITAL BUDGET

The budget serves as the focus for major decisions on the allocation of funds among operating programs, capital expenditures, and pricing of services. From the viewpoint of assisting in management decisions, the present budget in many hospitals has a number of deficiencies. The most important of these occurs because the budget's format (shown in Table 1 for Westfield Hospital) is that of a profit-making firm. It stresses those items of information and focuses attention on those aspects of operation that would be important to an enterprise attempting to maximize profit. But the hospital is in business to serve the community, not to maximize profit; thus, the budget should focus attention on the information appropriate to decisions in a nonprofit enterprise.

The hospital differs in two fundamental respects from a profit-making firm. Unlike a profit-making firm, the hospital need not cover its expenses from patient or third party revenue; its deficit can be met by philanthropic funds. Second, the management of the hospital wishes to provide the mix of services that benefits the community the most, not the mix that is most profitable. The profit-making firm depends upon market demands to determine its mix of goods and services. The hospital produces services not economically justified by consumer demands. For example, it provides care to low income families who could not afford to buy the services at market prices; it conducts research to advance the state of medical knowledge; and it helps to train young physicians. Such activities often will not be profitable, though they may well be in the community's interests. To focus upon profit or loss does not provide a complete picture of whether the hospital is operating most effectively in the community's interests.*

*In the language of the economist, there are external benefits present because the hospital is not able to charge all the beneficiaries of its services. Hence, certain activities that do not meet the usual market test of profitability may still be in society's interests.
Table 1

PRESENT BUDGET FORMAT: HYPOTHETICAL INCOME AND EXPENSES,
WESTFIELD HOSPITAL
(thousands of dollars)

<table>
<thead>
<tr>
<th>Item</th>
<th>Revenue</th>
<th>Expense</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administrative and General</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>Household and Property</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>Day Rate Service</td>
<td>2,500</td>
<td>2,000</td>
</tr>
<tr>
<td>Special Service</td>
<td>1,500</td>
<td>1,000</td>
</tr>
<tr>
<td>Out-Patient and Related Service</td>
<td>1,000</td>
<td>1,500</td>
</tr>
<tr>
<td></td>
<td>5,000</td>
<td>5,300</td>
</tr>
<tr>
<td>Less: free service</td>
<td>1,000</td>
<td></td>
</tr>
<tr>
<td>bad debts</td>
<td>200</td>
<td>1,200</td>
</tr>
<tr>
<td>Net Operating Revenue</td>
<td>3,800</td>
<td></td>
</tr>
<tr>
<td>Nonoperating Revenue</td>
<td>1,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4,800</td>
<td>5,300</td>
</tr>
<tr>
<td>Depreciation</td>
<td></td>
<td>700</td>
</tr>
<tr>
<td>Operating Deficit</td>
<td>1,200</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Revenue</td>
<td>6,000</td>
<td></td>
</tr>
<tr>
<td>Nonoperating Expenditures</td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>Total Expenditures</td>
<td></td>
<td>6,100</td>
</tr>
</tbody>
</table>
THE REVISED BUDGET

We have designed a revised budget format that focuses attention on the philanthropic and community service aspects of hospital operations. Table 2 presents the operating budget of Westfield Hospital in this revised format. The major changes are the expansion and addition of items dealing with the sources and uses of philanthropy. Before discussing these changes in detail, several other changes should be noted.

Income and Expenses

All of the operations of the hospital regardless of purpose or source of funding appear in the suggested general budget. To determine appropriate prices and quantities of various hospital services, management should have information about all inputs used and all outputs produced.* Therefore, in the revised budget income and expenses associated with research activities are included; the cost of capital is treated as a regular expense of doing business, since that is exactly what it is; and finally, under Cost of Services are included the value of services contributed by physicians in return for staff privileges and the value of services of volunteer workers. Contributed services have been valued at their cost if purchased. These services provide benefits to the community just as much as paid labor. Omitting contributed services would badly distort the apparent extent and mix of various hospital operations (as well as the extent of philanthropy). Hence, it is important that they be explicitly recognized and budgeted. Thus, although neither depreciation nor contributed services give rise to a money expense to the hospital, they both represent resources that could have been used in alternative ways by the community if not provided to the hospital.

*Note that the hospital must determine both price and quantity; because it provides charitable care, its price will frequently be below the market-clearing price.
Table 2

STATEMENT OF SERVICES, INCOME, AND PHILANTHROPY,
WESTFIELD HOSPITAL

<table>
<thead>
<tr>
<th>Services, Income, Philanthropy</th>
<th>Dollars (Thousands)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost of Services Provided</strong></td>
<td></td>
</tr>
<tr>
<td>1. Operating Expenditures</td>
<td></td>
</tr>
<tr>
<td>A. Hospital and Clinics</td>
<td>5,300</td>
</tr>
<tr>
<td>B. Research and Related Activities</td>
<td>1,000</td>
</tr>
<tr>
<td>2. Contributed Services -- Cost if Purchased</td>
<td></td>
</tr>
<tr>
<td>A. Volunteer Workers</td>
<td>100</td>
</tr>
<tr>
<td>B. Visiting Attending Physicians</td>
<td>500</td>
</tr>
<tr>
<td>3. Cost of Capital</td>
<td>700</td>
</tr>
<tr>
<td><strong>Total Cost</strong></td>
<td>7,600</td>
</tr>
<tr>
<td><strong>Revenue Other than Philanthropy</strong></td>
<td></td>
</tr>
<tr>
<td>1. Patient Payments less Bad Debts</td>
<td>1,500</td>
</tr>
<tr>
<td>2. Insurance Payments</td>
<td>2,000</td>
</tr>
<tr>
<td>3. Grants and Contracts for Services</td>
<td>300</td>
</tr>
<tr>
<td>4. Research Grants and Contracts and Other Related Income</td>
<td>1,000</td>
</tr>
<tr>
<td><strong>Total Operating Revenue</strong></td>
<td>4,800</td>
</tr>
<tr>
<td><strong>Philanthropic Income</strong></td>
<td></td>
</tr>
<tr>
<td>1. Financial</td>
<td></td>
</tr>
<tr>
<td>A. Endowment and Trust Income</td>
<td>200</td>
</tr>
<tr>
<td>B. United Way</td>
<td>200</td>
</tr>
<tr>
<td>C. Other Community Gifts</td>
<td>200</td>
</tr>
<tr>
<td>D. Special Fund Disbursements</td>
<td>400</td>
</tr>
<tr>
<td>E. Planned Use of Endowment</td>
<td>0</td>
</tr>
<tr>
<td>2. Contributed Services</td>
<td></td>
</tr>
<tr>
<td>A. Volunteer Workers</td>
<td>100</td>
</tr>
<tr>
<td>B. Visiting Attending Physicians</td>
<td>500</td>
</tr>
<tr>
<td>3. Value of Capital Used</td>
<td>700</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>2,300</td>
</tr>
<tr>
<td>4. Unintended Philanthropy</td>
<td></td>
</tr>
<tr>
<td>A. Unbudgeted Use of Financial Assets</td>
<td>500</td>
</tr>
<tr>
<td><strong>Total Philanthropic Contributions</strong></td>
<td>2,800</td>
</tr>
<tr>
<td><strong>Total Revenue</strong></td>
<td>7,600</td>
</tr>
</tbody>
</table>

**Uses of Philanthropy**

1. Subsidies to Patient Care
   A. Free Service Allowances | 1,000 |
   B. Other                   | ?     |

2. Subsidies to Teaching
   ?

3. Subsidies to Research
   A. Budgeted Subsidies       | ?     |
   B. Other                   | ?     |

4. Excess Costs of Operation
   Total                      | 2,800 |

Notes:
*The numbers, though consistent with Table 1, are hypothetical.
? indicates the entries cannot be calculated from information in the budget in Table 1.
Sources and Uses of Philanthropy

Whereas the usual budget stresses profit and loss, the revised budget highlights the sources and uses of philanthropy. The use of charitable contributions to provide unprofitable, though desirable services is what distinguishes a community hospital from a business enterprise. Obtaining community funds and dispensing them for the benefit of the community should be major concerns of management and should be reflected in the budget format.

Several aspects of the treatment of philanthropic contributions in the revised budget should be noted. First, the extent of Total Philanthropy is revealed to be $2.8 million in the revised budget, whereas only the category of Nonoperating Revenue ($1.0 million) can be clearly identified as philanthropy in Table 1. Second, the category of Operating Deficit in the present budget has been replaced by Unintended Philanthropy, which indicates the actual performance of the hospital relative to planned performance. When unintended philanthropy is greater than zero, it indicates that the operating deficit is greater than the planned. (The planned deficit equals expected philanthropic donations plus planned use of endowment.) In terms of the resources used to provide services, it is impossible to distinguish between intended and unintended philanthropy. Our proposed budget, therefore, treats unintended philanthropy as merely one item of total philanthropy, rather than as a separate "deficit" item, since such a separation might lead to error when decisions to reduce total philanthropy (that is, the operating deficit) are under consideration.

The three categories of Subsidy (Patient Care, Teaching, Research) reflect the three general types of activity conducted by the hospital. As noted in the Introduction, the magnitude of patient care subsidy is an indication of the net benefit being provided the community through this activity. The magnitude of subsidy in the other two areas indicates the extent to which local philanthropy is underwriting these activities. The category Excess Costs of Operation (shown under Uses of Philanthropy) measures the difference between: (1) the costs of providing patient care services at the hospital and (2) the prevailing
price for comparable services elsewhere in the community. It is a measure of the extent to which philanthropy is being used to subsidize inefficiency. If it could be reduced, more services of benefit to the populace could be provided.

At the present time, hospitals do not collect the information necessary to estimate the magnitude of all of the uses of philanthropy. Although free service allowances (discounts from full-price charges) and the general fund contribution to research frequently appear in budgets, other items that one would need to know to calculate total subsidies in the various categories are usually not available. The question marks in Table 2 indicate the entries that cannot presently be calculated from information in most hospitals' budgets. In the example shown in Tables 1 and 2 only $1.0 of the $2.8 million of philanthropy can be identified as to its usage. It is unclear how much of the remaining philanthropy is subject to review by management.

A basic requirement for improving management decisions is the ability to collect and display data that reveal in detail the uses of Philanthropy. This is not a simple requirement, since many of the concepts that underlie the subcategories of subsidy are not well developed. In this Memorandum we attempt to develop the necessary concepts and show how they can be applied to improve management decisions. This requires a detailed examination of the actual activities underlying the budget entries; so to keep the task manageable, we chose to restrict the initial analysis to the Outpatient Department.
III. BUDGETING AND ANALYSIS OF THE OUTPATIENT DEPARTMENT

THE OUTPATIENT DEPARTMENT: A SKETCH

The Outpatient Department at Westfield Hospital consists of a number of clinics, most of which share common facilities and a common nursing staff, but which meet at different times. The clinics are organized according to specialty; there is a Medical Clinic, a Psychiatric Clinic, a Dermatology Clinic, and so on. By far the largest "clinic" is the Emergency Room, which accounts for over 40 percent of the total visits to the OPD. It is open 24 hours per day.

With a few exceptions the visit charge to a full pay patient in any clinic is the same. In addition there is a charge for ancillary services (laboratory tests, X-rays, electrocardiograms, electroencephalograms, and so forth). The charge for ancillary services to the full pay patient generally approximates the market price. All patients coming to the OPD are rated into one of six pay classes: full pay, or discounts of either 20, 40, 60, 80, or 100 percent (complete free service). Until recently, few patients were in the full-pay category since, in general, full-pay patients were expected to see a private physician. With the advent of Medi-Cal and other third party reimbursement programs, the hospital finds that more of its patients are in the full-pay classification.

APPROACH TO ANALYSIS

At the outset of this study, the OPD was commonly conceded both to present problems for the hospital management and to be an area about which relatively little was known. The problems were thought to lie in two areas -- a large deficit was being incurred at a time when the hospital's overall deficit was considered excessive and the service provided in the OPD was not satisfactory to either patients or physicians.

As we viewed the situation, the objective of management should be to obtain the maximum community benefits from OPD operations for any given deficit incurred by that department. If budgetary considerations make it necessary to decrease the deficit, this should be done
in the way that causes the smallest decrease in community benefits. We therefore focused our attention on analyzing the relationships among the various activities of the OPD, the size of deficit incurred, and the amount of community benefit obtained.

As noted previously, the amount of community benefit yielded by hospital activities is a function of the teaching, research, and patient care activities. In the case of the OPD at Westfield Hospital, research activities were sufficiently small to be safely ignored; thus we were able to narrow the problem to one of considering only the teaching and patient care activities of the OPD. As a further simplification, we did not consider any changes in the teaching program; thus we did not explicitly consider the community benefit provided by the teaching activities. This permitted us to concentrate upon analyzing the cost and benefits associated with the patient care activities of the OPD. In line with the discussion of the Introduction (page 5), we formulated the objective to be to maximize the patient subsidy dispensed, subject to the desired limit on the size of deficit incurred.

An important effort in our analysis was to understand how costs arose in the clinics and to determine whether these costs seemed justified. To accomplish this, we developed an approach to analysis that has subsequently proved extremely helpful in analyzing operations in several other clinics. The two important elements of this approach are:

1. To use private office practice as a standard of comparison in analyzing clinic costs. Each specialty clinic is compared with the corresponding private specialty practice.

2. To divide the total costs of providing physician visits into two parts: the direct labor costs of the physician services and all other (non-physician) costs. Visit costs in clinics and in private offices are then compared separately for each component.

Approaching the analysis of costs in this manner has a number of advantages. First, using private office costs as a standard for
comparison gives a fixed point of reference that is independent of a clinic's own performance. Private office practice is an appropriate standard, since the services provided by most clinics are also provided in private practice. Second, comparing physician costs in the clinic with those in private practice allows one to estimate the effect of the teaching program on clinic costs, since almost the entire influence of teaching will be on the amount and cost of physician time per visit. Third, looking at non-physician costs separately minimizes the confusing influence of teaching and "quality of care" differences when comparing the efficiency of clinic operations to those in private practice. Of the functions performed by non-physician personnel, only a portion of nursing appears related to either teaching or quality of care; thus appeals to the influence of the teaching program or to the higher quality of care cannot be used to justify a substantial excess of non-physician costs in a clinic as compared to private practice.

The method of analyzing clinic costs is illustrated for a hypothetical specialty clinic in Table 3. The total difference in per visit costs between the clinic and private practice is $4.00, $2.00 of which represents a difference in physician costs (which we attribute to teaching), and $2.00 of which represents excess costs in the non-physician aspects of operation. The application of this methodology is illustrated in more detail in the following sections.

As will be seen, our analysis at Westfield Hospital indicated that some portion of philanthropy devoted to the OPD went to support inefficiency of operation. We have found this to be the case at two other clinics that we have examined in detail; thus this result may be common to many clinics.

Because we assumed that the conclusion of the existence of excess costs would be subject to critical review, we took great care to assure the reasonableness of our estimates of market prices and costs. Market prices were based on regional surveys of physician charges, adjusted upward in some instances to reflect the special nature of services dispensed by Westfield. For those clinic services for which prevailing prices in private practice were not commonly available, we relied upon
Table 3
A COMPARISON OF PER VISIT COSTS IN
A CLINIC AND IN PRIVATE PRACTICE

<table>
<thead>
<tr>
<th></th>
<th>Clinic Costs</th>
<th>Private Practice Costs</th>
<th>Difference in Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physician</td>
<td>$8.00</td>
<td>$6.00</td>
<td>$2.00 (Teaching Costs)</td>
</tr>
<tr>
<td>Non-Physician</td>
<td>$6.00</td>
<td>$4.00</td>
<td>$2.00 (Excess Costs)</td>
</tr>
<tr>
<td>Total</td>
<td>$14.00</td>
<td>$10.00</td>
<td>$4.00 (Total Difference)</td>
</tr>
</tbody>
</table>
discussions with the clinic personnel to estimate an approximate "market price." Physicians who were asked to review these prices indicated that they appeared quite reasonable. The division of private practice costs into physician and non-physician components was based on Medical Economics survey data. Our estimate of clinic costs was based on a detailed examination of actual services and staffing. Our approach to estimating costs is described in a later section.

Following the examination of costs, the extent and distribution of subsidies to patient care were analyzed. The analysis showed that the pricing policy being used resulted in a distribution of subsidies that differed markedly from declared hospital policy. An improved pricing policy is suggested that would remedy this problem. This new policy would not only bring actual subsidies more closely into line with declared policy but would substantially decrease the OPD deficit.

Finally, the concept of maximizing subsidy to patient care was applied to determine the "best" level of operation for the various clinics of the OPD. This analysis shows the dangers of reducing operations in a large deficit clinic in the hope of saving money.

SUBSIDY TO THE TEACHING PROGRAM

The first step in the analysis was to ascertain what portion of the costs of the OPD clinics arose because of the teaching program. Since clerical and nursing personnel are not heavily involved in actual teaching activities, the assumption was made that the difference in cost attributable to teaching is reflected entirely in physician costs. Physician costs might be either raised or lowered by the teaching program. They might be raised for two reasons: (1) full-time staff and visiting attending physicians supervise and teach house staff, adding to physician time and cost; (2) interns and residents are not as skilled as older physicians in providing care, and hence will take longer to process patients. On the other hand, total physician cost in a clinic might be lower than in private practice because salaries of the house staff are far below those of more experienced physicians.
Since physicians do no teaching in their private practice, we found the physician cost of patient care activities (as distinct from teaching activities) by determining the private physician's net return per visit (the amount he keeps after paying expenses) in various specialities. This was compared with the physician "costs" of the clinic, which were set equal to the cost of full-time staff, plus the cost of house staff, and plus the market value of any visiting attending physician services that might be used (market value is what the attending physicians would earn in private practice during the time they spend in the clinic). Since physician costs in a clinic include the physician cost of patient care and the cost of teaching, the difference between physician costs in a clinic and physician costs in private practice (for the same specialty) equals the cost of teaching. In symbols, \( CT = PCH - PCM \) where \( CT \) is the cost of teaching and \( PCH \) and \( PCM \) are the physician costs at the hospital and on the market respectively.

An example may make this clearer. If a clinic used one intern-hour, one full-time staff hour, and one visiting attending physician-hour, whose costs were \$4, \$10, \$18, respectively (assuming the attending physician could make \$18 an hour in private practice after paying his overhead expenses), to produce eight patients visits, the physician cost at the hospital would be \$4 + \$10 + \$18 = \$32, or \$4 per visit. If a physician in private practice could see six patients in one hour and net \$18, the physician cost in private practice would be \$3 per visit. The per visit cost of teaching would thus be \$4-\$3, or \$1 per visit.

Table 4 shows some hypothetical but representative estimates of teaching costs, by clinic. Of all the clinics, the Emergency Room shows the most "profit" (that is, lowered cost) from the teaching program. This is not surprising, since it has no full-time staff or visiting attending physicians, but only interns and residents, whose salaries are low relative to the market price. Thus, if the Emergency Room did not have low-cost physicians drawn from the teaching program,
### Table 4

**TEACHING COST, BY CLINIC**

<table>
<thead>
<tr>
<th>Clinic</th>
<th>Cost per Visit</th>
<th>Annual Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allergy</td>
<td>$ -2.00</td>
<td>$ -5,000</td>
</tr>
<tr>
<td>Cardiac</td>
<td>9.00</td>
<td>15,000</td>
</tr>
<tr>
<td>Dermatology</td>
<td>-3.00</td>
<td>-5,000</td>
</tr>
<tr>
<td>Ear, Nose, Throat</td>
<td>-3.00</td>
<td>-10,000</td>
</tr>
<tr>
<td>Emergency</td>
<td>-10.00</td>
<td>-200,000</td>
</tr>
<tr>
<td>Eye</td>
<td>11.00</td>
<td>60,000</td>
</tr>
<tr>
<td>Medical</td>
<td>3.00</td>
<td>30,000</td>
</tr>
<tr>
<td>Neurology</td>
<td>1.00</td>
<td>1,000</td>
</tr>
<tr>
<td>Pediatric</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Psychiatry</td>
<td>5.00</td>
<td>14,000</td>
</tr>
<tr>
<td>Average</td>
<td>-2.00</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>$ -100,000^b</td>
</tr>
</tbody>
</table>

**Notes:**

^aAll numbers are hypothetical.

^bThis negative cost means that, without the teaching program, costs of operating the clinics would be higher.
costs would be $10.00 per visit higher. At the same time, in the Cardiac Clinic, where the full-time and visiting attending physicians generally handle the patient load and the house staff is not necessary for patient care purposes, teaching costs were $9.00 per visit. In other words, without the interns and residents and the time spent by full-time staff and visiting attending physicians supervising their work, costs (including the market value of attending physicians' services) would be $9.00 lower per visit. Although some clinics show positive teaching costs and other clinics show negative teaching costs, on balance "costs" are negative. That is, without the teaching program, the costs of operating the OPD would be higher than at present. This is in accord with the actual finding at Westfield Hospital.

Because teaching generates no revenue, the cost of teaching can be taken as an estimate of the current "subsidy" to teaching from the hospital's philanthropic resources. In the case of Westfield Hospital, the subsidy was negative; the hospital spent less for its OPD than it would have if the teaching program were not in operation.

**COST OF INEFFICIENCY OR EXCESS COSTS OF SERVICES**

The next step was to estimate which of the remaining costs arose because of inefficiency of operation. Clinic visit costs were first adjusted by subtracting teaching costs from total costs.* These costs adjusted for teaching were then compared with private physicians' costs for providing similar services, in order to see whether the hospital was more or less costly.** We defined "the excess cost of services at the hospital" (EC) as follows: \( EC = MC + CL - CT - VMP \), where MC is the market cost of inputs bought on the market by the hospital, CL is the value of labor contributed to the hospital, CT is the cost of

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*In instances where research is important, the costs of research activities also would need to be subtracted from total costs before proceeding with the analysis.

**Because we attributed any differences in physician costs to teaching, this is equivalent to comparing the hospital's "overhead" (non-M.D. costs) with a private physician's "overhead."
teaching as defined above, and VMP is the cost of the medical service if purchased from a private physician (value at market price).*

To illustrate the methodology, we use the Emergency Room as an example. Total annual costs in the Emergency Room are assumed to be $400,000. Table 4 indicates they would be $200,000 higher if the hospital had no teaching program. Thus, without a teaching program, costs would be $600,000 annually. Suppose it is estimated that the equivalent of a visit to the Emergency Room can be purchased for $16 on the market. Then the cost of the 25,000 annual visits to the Emergency Room, if bought on the market would be 25,000 x $16 or $400,000. The difference between $600,000 and $400,000 is an estimate of the amount by which costs (adjusted for teaching) in the OPD exceed costs on the market for similar services. Thus, the difference is a measure of the efficiency of the hospital relative to private physicians in producing the services in question.

**EXAMINATION OF CLINIC COSTS**

When our calculations at Westfield suggested that excess costs in the OPD might be important, we decided to make a detailed analysis of OPD costs in order to assure that the cost figures used were accurate, as well as to identify those areas where improvement in efficiency appeared possible. Because of its size, we paid particular attention to the Emergency Room.

Costs per visit for the clinics were determined separately for each of the various components of the total operation. The components considered at Westfield Hospital were: triage, registration, financial interviewing, screening, physician services, nursing (including aides), medical supplies, ancillary services, cashiering, medical records, accounting and billing, public health nursing, OPD administration, housekeeping, miscellaneous supplies, depreciation, and hospital supporting

*Since the cost of teaching (CT) equals the subsidy to teaching (ST), EC = MC + CL - ST - VMP. This definition is employed in Appendix B.*
services. Costs were established for each component on the basis of staffing, salary, and supply-cost information. Nursing, physician, and ancillary-service costs were obtained separately for each clinic. Where a particular operation serviced more than one clinic, costs of that operation were divided among the clinics on the basis of either number of visits (for example, medical records) or clinic size as measured by direct clinic expenses (such as OPD administration). While such a division has an obvious amount of arbitrariness, the results it yields are nevertheless useful.

Physician costs for each clinic were determined from answers to a questionnaire. Clinic heads were asked for the number of hours the various categories of physicians actually worked in a specified month, and an hourly wage rate for each type of physician was applied to this information to derive physician costs by clinic.* Total nursing costs by clinic were found by multiplying together (1) the number of nurses usually assigned to a clinic, (2) the number of hours the nurses work, and (3) the hospital's average hourly nursing wage rate. Ancillary services used by each clinic were estimated from a random sample of patient bills, and cost estimates for these services were made.

After determining the monthly costs for a specific clinic by component, we translated these into per-visit figures by dividing by the number of monthly visits to the clinic. When the figures were viewed in this manner, high-cost components of operation were readily visible. A person familiar with the tasks being performed could readily identify those places where the costs were out of line with the nature of the tasks being performed. We wish to stress the value and general applicability of this approach to cost analysis. It is simple and yet can pinpoint areas that should receive management attention.

*The clinic cost figures included a value attributed to services performed by visiting attending physicians. The hourly value of these services was determined separately for each specialty; it was set equal to the estimated hourly gross revenue in private practice, less overhead expenses.
SUBSIDY TO PATIENT CARE AND PRICING POLICY

After examining the subsidy to teaching and identifying areas of excess cost of operation, we turned our attention to the subsidies to patient care provided by the clinics of the OPD. The subsidy received by a patient is defined as the difference between what he would pay for a medical service if obtained from a private physician and what he actually does pay at the hospital. As explained in the Introduction, the magnitude of the subsidy to patient care measures the benefit provided the community by the patient care activities of the OPD. Because community benefit is the ultimate objective of hospital activities, we examined the extent and distribution of patient subsidies in the OPD at Westfield in detail. Our approach to analysis and the qualitative nature of our findings are described below.

An early step in our analysis was to consider how closely the actual distribution of patient subsidies conformed to the one implied by hospital policy on charitable ("free service") allowances. We found a number of serious discrepancies. For example, full-pay patients sometimes received subsidies and sometimes paid more for service than if they had gone to a private physician. These and other anomalies in the distribution of patient subsidies arose because Westfield had an identical visit charge (whether initial or return) to full-pay patients for virtually all clinics, whereas the prices charged in private practice differ considerably for different types of visits.

The way in which the pricing policy of the hospital affected the distribution of patient subsidies is best understood by dividing total subsidy to patient care into two parts: Free Service and Other Subsidy. Free Service is the amount of the discount from the full-pay charge that the hospital gives to lower income patients; Other Subsidy equals the private-practice charge (market price) less the hospital full-pay charge (hospital price).* If the hospital price equals the market price,

*In symbols, \( S_{PC_i} = MP_i - AR_i \), where \( S_{PC_i} \) is the per visit subsidy to patient care in the \( i^{th} \) clinic, \( MP_i \) is the market price for the service
Other Subsidy will equal zero and all patient subsidy will be dispensed through Free Service Allowances. When the full-pay charge is less than the market price, Other Subsidy is positive, and this amount of patient subsidy is being provided to all OPD patients, regardless of their ability to pay. A negative Other Subsidy arises when the hospital price exceeds the market price; it indicates the amount of "subsidy" that full-pay patients are giving to the hospital. Even part-pay patients are subsidizing the hospital whenever Other Subsidy is negative and larger than Free Service.

For example, suppose a routine visit to a private dermatologist costs $9.00 and the hospital price for a clinic visit is $12.00. The full-pay patient and the patient with a 20 percent discount on his bill will pay more than the market price. For the 20 percent discount patient visiting the Dermatology Clinic, budgeted Free Service is $2.40 (.2 x $12), but Other Subsidy is -$3 ($9-$12); thus subsidy to patient care is -$$.60 (he pays $$.60 more than the market price). Alternatively, suppose the market price for the equivalent to an Emergency Room visit is estimated to be $20. If the hospital price is $16, full-pay patients in the Emergency Room receive a $4 subsidy even though they receive no Free Service Allowances. Whenever Other Subsidy is positive this dollar amount of subsidy is being provided to every patient regardless of his ability to pay.

The question of the most appropriate pricing structure for the OPD is a complex one. As the discussion above indicates, pricing is intimately related to the extent and distribution of philanthropy dispensed by the OPD. It is also directly related to the deficit of the OPD, since the lower the price charged, the less the revenue generated and

provided in the \( i \text{th} \) clinic, and \( AR_i \) is the amount paid to the hospital per visit to the \( i \text{th} \) clinic. Subsidy to patient care, Free Service (\( FS_i \)) and Other Subsidy (\( OS_i \)) are related by: \( SPC_i = OS_i + FS_i \), or \( SPC_i = (MP_i - P) + (P - AR_i) \), where \( P \) is the hospital's full-pay charge for a visit to the \( i \text{th} \) clinic.
the greater the operating deficit.* The complexity of the considerations involved in choosing a deficit level for the OPD and deciding on the distribution of subsidies among clinics and income groups means that the preferred pricing structure for the clinics is far from obvious.**

Although we have no final answers on pricing, it does seem clear that the policy of charging a uniform price can be improved upon. Two obvious alternatives are to base prices on average costs for each clinic or upon the prices that would be charged in private practice. Basing prices upon average costs would have few advantages and would preserve the undesirable features of the uniform pricing policy with respect to the distribution of subsidy.*** That is, either full-pay patients would receive a subsidy (if the market price were greater than the cost) or full-pay and perhaps some part-pay patients would pay more than the market price (if the market price were less than cost). Also, the difficulty of determining cost (in particular, to what extent the

* Assuming that visits do not increase sufficiently to offset the lowered revenue per visit and the cost of the additional visits.

** Given some assumptions, one can show that the community is best off if the hospital prices its services at the cost of producing an additional visit. One of the assumptions is that the hospital not go broke if it does price its services in this fashion. Another is that the care provides a benefit only to the individual receiving it and not others. Unfortunately for this pricing criterion, neither assumption is likely to be valid. Thus, management must find what the economist calls the "second best" outcome. This is difficult to do operationally.

*** The advantage of using cost-based pricing is that it presumably would lead consumers to use the OPD for services in which it was efficient relative to the market. However, this is not likely to happen. Because full-pay patients generally have insurance and because the hospital's price to part-pay patients would still generally be below market, little specialization would probably result. Also, there are constraints on the extent of specialization because of the teaching and research programs. Finally, it is the cost of an additional unit and not average cost that is relevant, but marginal cost pricing would presumably lead to unacceptable deficits. The discussion in the next section introduces a method for the hospital to expand those parts of its operation in which it does better than the market, contract those in which it does worse, and still keep market prices.
hospital's overhead should be included) is a very real drawback on the use of costs as a basis for prices. *

We believe that the preferred alternative is to establish clinic visit charges based upon the market price, that is, establish prices such that the full-pay patient would pay the same as at a private physician's office. Charges could be established within each clinic based upon the California Relative Value Scale. The basic charge per RVS unit could differ among clinics. One possibility is to have the medical staff of each clinic suggest an appropriate basic charge, with the final determination being made by a committee appointed for that purpose.

Charging the market price makes the category Other Subsidy equal to zero by definition. ** This eliminates the subsidy that is at present going to full-pay patients in those clinics where the market price is greater than the hospital price. Eliminating this subsidy seems particularly desirable in view of the fact that full-pay charges are generally paid by a third party. Perhaps more important, since Other Subsidy would be zero, all subsidies to patient care would be in the form of Free Service Allowances; thus, actual subsidies would conform to the policies established in the setting of Free Service Allowances. As compared to having the same price for all visits, the proposed market-based prices would result in shifting the distribution of patient care subsidies to the lower income groups. This effect is illustrated by the hypothetical numbers in Table 5. Although total subsidy to patient care drops by 25 percent ($240,000), the subsidy going to the 40 percent of the patients in the three lowest "pay classes" (roughly equivalent to income groups) decreases by only 8 percent ($45,000). This result is qualitatively similar to that obtained using the actual data from Westfield Hospital.

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* Theoretically, price should be set (and fixed costs allocated) so that (1) the marginal consumption of every service has the same social value and (2) the hospital breaks even. In practice this is not an operational criterion.

** Except the amount charged patients but not paid (bad debt).
### Table 5

**DISTRIBUTION OF SUBSIDIES TO PATIENT CARE ACROSS INCOME CLASSES**

<table>
<thead>
<tr>
<th>Pay Class</th>
<th>Subsidies to Patient Care</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amount (thousands of dollars)</td>
<td>Percent of Total</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Present Prices</td>
<td>Proposed Prices</td>
<td>Present Prices</td>
</tr>
<tr>
<td>Full Pay</td>
<td>80</td>
<td>20&lt;sup&gt;b&lt;/sup&gt;</td>
<td>8.3</td>
</tr>
<tr>
<td>20 percent off</td>
<td>165</td>
<td>85</td>
<td>17.2</td>
</tr>
<tr>
<td>40 percent off</td>
<td>165</td>
<td>110</td>
<td>17.2</td>
</tr>
<tr>
<td>60 percent off</td>
<td>255</td>
<td>225</td>
<td>26.5</td>
</tr>
<tr>
<td>80 percent off</td>
<td>255</td>
<td>240</td>
<td>26.5</td>
</tr>
<tr>
<td>100 percent off</td>
<td>40</td>
<td>40</td>
<td>4.2</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>960</strong></td>
<td><strong>720</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

**Notes:**

<sup>a</sup> Figures are hypothetical, but change in distribution of subsidy among pay classes follows the same pattern as figures at Westfield Hospital.

<sup>b</sup> The $20,000 is the expected bad debt from full pay patients.
A side effect of revising prices to conform with private physician charges is that it will change the hospital's revenues and thus change its operating deficit. In the example illustrated in Table 5, it will decrease the deficit. Assuming that visits and pay-class mix do not change, the change in the deficit would equal the change in the total subsidy (in the case illustrated, a decrease of $240,000). Although this is clearly a desirable occurrence given a shortage of funds, the primary objective of revising prices is to distribute subsidies more in accordance with hospital policies rather than to raise more revenue. The overall deficit that can be incurred by the hospital is an important constraint, but decisions on the uses of philanthropy should reflect the objective of maximizing the benefit to the community given the constraint on deficit size. This principle underlies our recommendation on pricing policy. It also underlies the discussion in the next section dealing with decisions on the level of operation in various clinics.

There are, of course, benefits other than the provision of care to needy patients that are important to management. Such benefits may cause management to alter the pricing scheme outlined above. For example, it may be necessary to lower the price in a particular clinic to obtain sufficient teaching material. Or the community may wish to subsidize some clinics more than others. We regard the market price as only a first approximation to the optimal pricing structure and recognize that some deviation from market price may be desirable.

Before concluding this section, we would like to emphasize the value of the type of information presented in Table 5. That table shows

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* See Appendix B for a formal expression of this statement.

** Charging the market price has the theoretical disadvantage of passing along any monopolistic rents that may be present in the market price for physicians' services. However, use of the market price is advocated on equity grounds; that is, that it would achieve a more desirable distribution of patient subsidies among income groups. There is an additional question of the impact of these prices on economic efficiency. Such a question is difficult to answer because of externalities. Charging the market price, in effect, picks a price that is arbitrary on efficiency grounds and desirable on equity grounds.
the amount of philanthropy that is going to persons in various income classes. Under the revised pricing policy, the distribution of subsidy depends entirely upon the characteristics of free service policy. One of the functions of the Board of Trustees should be to continually review the distribution of subsidy to various income groups and to decide whether it appears satisfactory to them. If they find too great an amount going to a particular group, they can take steps to revise the policies used in determining free service allowances.

Information on the quantity and distribution of subsidies is among the most important indicators of the benefits the hospital provides to the community. In most hospitals, this information is not now a part of management reports. We urge that it be made available to management on a routine basis.

CHOOSING THE LEVELS OF OPERATION

The management of any hospital OPD is continually faced with decisions on the level of operations of the various clinics. These decisions become particularly acute when the overall deficit of the Outpatient Department is considered excessive. Almost all clinics in an OPD generally run at a deficit, some of them very substantial. When the total deficit is considered too large, there may be an understandable tendency to consider curtailing services in those clinics with the largest deficit. As discussed below, such a tendency would be disadvantageous on two counts: first, reducing the level of operations in a clinic may actually raise the deficit of the OPD; and second, even if the deficit is not increased, the loss in community benefit may be greater than is justified by the budgetary savings.

Reducing clinic operations will increase the deficit whenever the cost savings are less than the revenue reduction. Because many of the costs of operating the hospital and the outpatient clinics are relatively independent of the scale of operation, this is commonly the case. Indeed, in almost every clinic at Westfield, we found that the deficit would be increased by decreasing the level of operation (and reduced by increasing it).
But, even if the deficit of a clinic could be reduced by reducing its scale of operation, taking such an action could very well be undesirable. The hospital should attempt to provide the mix of services that will yield the maximum benefit to the community, subject to a constraint on the maximum deficit allowable. A large deficit in a particular clinic is not necessarily bad, since the clinic may very well provide a substantial benefit to the community. The appropriate measure of clinic performance is the amount of community benefit per dollar of deficit incurred. If budgetary constraints force the hospital to reduce the overall level of deficit, the object should be to make those changes that will cause the required reduction in deficit with the minimum loss of community benefits. Assuming that there are clinics where reducing the level of operation will reduce the deficit, the most preferable clinics to curtail are those where the loss in community benefits per unit reduction in deficit is the smallest.

In our analysis at Westfield Hospital, we assumed that the change in subsidy to patient care (as previously defined) measured the change in benefit to the community resulting from changes in the level of clinic operations. This seemed reasonable because we considered only moderate changes in the scale of operations; thus other factors affecting community benefit (such as the unique services of a clinic or its contribution to the teaching program) seemed unlikely to be affected. If more significant changes in scale were to be made, it would be necessary to consider explicitly these other factors.

Our objective, then, was to choose the level of activity for each clinic that would maximize the total patient subsidy being provided by the OPD, subject to a constraint on the allowable deficit. Of course, a hospital is not free to vary the scale of various clinic activities over an infinitely wide range. Even if price is reduced, there may not be enough patients to expand a clinic by a large factor. Conversely, if a clinic is contracted too greatly, the teaching or research programs of a hospital may be unable to function adequately. There will also be constraints imposed by the amount of space available for various clinics. The availability of space, the limits of demand, and the
requirements of the teaching and research programs all limit the scales of operation that can practically be considered by hospital management. Still, the objective should be to maximize the subsidy to patient care subject to the various constraints, including the budget constraint (that is, the size of the deficit).

Although the large number of practical limitations on feasible levels of clinic services may appear to make choosing an optimum mix of activities an impossibly difficult task, the techniques of linear programming can be used to solve the problem. At Westfield Hospital we found the best mix of clinic activities for various allowable total deficits, subject to the following additional constraints: (1) that the space required for clinic activities not exceed the available space; and (2) that the level of visits in every clinic remain within 25 percent of the current level. The restriction on patient loads to within 25 percent of current levels was arbitrary. We felt that changes of 25 percent in either direction were probably feasible in terms of patient demand and teaching activities; however, the methodology will handle other limitations just as easily. For example, an upper visit level and a lower visit level can be individually specified for each clinic.

Additional assumptions were then made: (1) that the distribution of patients by pay class would remain unchanged as the number of patients changes; (2) that the proportion of charges that became bad debts would remain the same; (3) that the hospital would charge market prices to its full-pay patients and base its discounts to part-pay patients on market prices; (4) that there was excess demand for each clinic, so that if additional clinic time were scheduled, demand would be forthcoming. We did not take account of any differential in waiting time between a private physician and the clinics (either waiting time for an appointment or waiting time at the clinic). A more complete analysis would net out from the subsidy to patient care the cost to the patient of any additional waiting time. The choice of optimum mix of activities was then formulated as a linear programming problem. Appendix A describes the information and procedures necessary to solve this particular
linear programming problem. An example solution using hypothetical numbers is presented below.

The clinics considered in the example provide $350,000 of subsidy to patient care annually; the deficit incurred to provide this subsidy is around $285,000 annually. The solution to the linear programming problem shows that considerably more subsidy to patient care could be obtained from existing resources. Alternatively, the deficit could be reduced if the hospital were willing to accept a lesser increase in the subsidy to patient care.

Point P in Fig. 1 shows the current position of the hospital: $350,000 of subsidy to patient care is being provided for $285,000 of deficit. The line QRS in Fig. 1 is the solution to the linear programming problem. It shows the maximum attainable subsidy to patient care for any given deficit subject to the constraints outlined above. Point Q shows the largest feasible reduction in the deficit from merely being able to increase or decrease clinic loads by 25 percent. Moving northeast from Point Q, the hospital can achieve a higher subsidy to patient care, but only at the cost of a higher deficit. Up to Point R the hospital is able to generate more than $1.00 in subsidy to patient care for each additional dollar of deficit. To the right of Point R, changing the level of services generates less than $1.00 in subsidy to patient care for each additional dollar of deficit. Operating in this region (RS) is generally undesirable: the hospital always has the option of increasing free service write-offs, and this will generate $1.00 of patient care subsidy for each additional $1.00 of deficit. The solid line from R to T shows the option of increasing free service allowances. Point T indicates the maximum patient care subsidy that can be realized without increasing the present deficit. The subsidy at T is $435,000, $85,000 more than at present. Thus, the line QRT shows the most efficient options open to the hospital.

We can also answer the question: What is the value of additional space? There is no value to expanding areas of the OPD not being used to capacity and not used to capacity in any proposed solution. For those areas used to capacity, if additional revenue generated by
Fig. 1—Potential improvements in subsidy-deficit positions from changes in levels of clinic operations
expansion exceeds the additional cost, expansion will reduce the deficit as well as increase the subsidy. The methodology for ascertaining the desirability of expansion is found in Appendix A.

The major conclusions derived from applying the linear programming model at Westfield Hospital were: (1) A substantial increase in the subsidy to patient care could be obtained by modifying levels of services. (2) In most clinics analyzed the hospital would incur a larger deficit if it reduced the scale of its services (the loss of revenue would exceed reductions in cost). (3) In most clinics analyzed the hospital would be better off in terms of both subsidy to patient care and deficit if it could expand visits although there were some clinics where it would be best to leave services unchanged.*

THE REVISED OUTPATIENT DEPARTMENT BUDGET

It is appropriate to conclude by showing how possible changes in OPD operations suggested by an analysis of the type described might influence the magnitude and uses of philanthropy. Table 6 shows the original and revised uses of philanthropy (the numbers are hypothetical but indicate the qualitative results found at Westfield Hospital). The revised policies show the combined effects of:

(1) **Improvements in efficiency of operations.** The analysis identified inefficiencies of operation totaling $200,000; thus a savings of $50,000 should not be difficult to achieve. This would reduce excess costs of operations and use of discretionary funds by $50,000.

(2) **Revising clinic prices to approximate prices charged in private practice.** This change would reduce the total subsidy to patient care and the use of discretionary funds by $240,000. Other Subsidy would be decreased by $440,000, to $20,000,** but Free Service Allowances would be increased by $200,000.

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*In these clinics there was a discontinuity in the marginal cost function at the present level of operations.

**The remaining "Other Subsidy" is bad debt.
Table 6

USES OF PHILANTHROPY IN THE OUTPATIENT DEPARTMENT<sup>a</sup> (thousands of dollars)

<table>
<thead>
<tr>
<th></th>
<th>Present Policies</th>
<th>Revised Policies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsidies to patient care</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free Service</td>
<td>500</td>
<td>765</td>
</tr>
<tr>
<td>Other</td>
<td>460</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>960</td>
<td>785</td>
</tr>
<tr>
<td>Subsidies to teaching</td>
<td>(100)</td>
<td>(100)</td>
</tr>
<tr>
<td>Subsidies to research</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Excess costs of operation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinics</td>
<td>200</td>
<td>69</td>
</tr>
<tr>
<td>Ancillary</td>
<td>(100)</td>
<td>(100)</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>(31)</td>
</tr>
<tr>
<td>Total philanthropy</td>
<td>960</td>
<td>654</td>
</tr>
<tr>
<td>Discretionary funds</td>
<td>710</td>
<td>400</td>
</tr>
</tbody>
</table>

Note:
<sup>a</sup>All numbers are hypothetical.
(3) Increasing clinic operations to the optimum level suggested by the linear programming analysis. The increase in scale of operations would lower the average cost of clinic visits sufficiently to reduce excess costs of operation by $81,000.* At the same time, the additional visits would generate a further $65,000 in Free Service subsidy and a reduction of $20,000 in the use of discretionary funds. They require an additional $4,000 of contributed labor.

As shown in Table 6, the revised policies increase free service by $265,000 ($200,000 plus $65,000); total subsidy to patient care is decreased by $175,000 ($240,000 minus $65,000); excess costs of operation are reduced by $131,000, with $50,000 of the decrease coming from improvement in the general efficiency of operation and an additional $81,000 from changes in the scale of operation. The cumulative effect of these revisions is to reduce the total philanthropy used in the OPD by $306,000, from $960,000 to $654,000. There is a corresponding reduction in the use of discretionary funds;** thus the revised policies would substantially lessen the drain of the OPD on the limited discretionary funds available to the hospital. Most importantly, however, the reduction of $310,000 in discretionary funds would be obtained at a cost of only $175,000 reduction in subsidies to patient care. If it so chose, the hospital could liberalize Free Service policies so that total subsidies to patient care were left unchanged. In this event, the output of the OPD as measured by subsidies to patient care would remain unchanged, but the use of discretionary funds would still decrease by $135,000 ($310,000 minus $175,000). Further, the revised pricing policy would direct a higher proportion of total subsidies to the neediest patients.

The proposed approaches to budgeting and to structuring and analyzing the operations of the OPD provide a better picture of the efficiency

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*Excess costs are lowered by the sum of the change in deficit and change in subsidy to patient care less the amount of increased contributed labor. For further explanation see Appendix B, equation (9).

**The reduction in the use of discretionary funds is $310,000 rather than $306,000 because the additional $4,000 Contributed Labor does not have to be paid for.
of operations, the extent and distribution of subsidies, and the areas of potential improvement. In short, they provide management with more relevant information than previously available to it by highlighting the extent of service to the community (as measured by the subsidies to patient care), the uses of philanthropic funds, and areas where cost might be reduced. These are exactly the areas in which management must make important decisions.
Appendix A

CHOOSING THE OPTIMUM MIX OF CLINIC ACTIVITIES

Mathematical programming is a technique designed to solve the following problem: If many activities each produce varying amounts of benefit by using varying amounts of limited resources, what feasible mix of activities produces the largest total benefit? Linear programming is a particular type of mathematical programming in which the assumption is made (among others) that the benefit per unit produced by any activity is independent of the scale of the activity. In the context of the OPD, each clinic is an activity; the scale of each activity is measured by clinic visits; each visit produces a certain benefit measured by subsidy to patient care; and there are certain constraints. The deficit in the OPD cannot exceed a certain amount; space requirements must be satisfied; and large changes in either direction in the number of visits may not be feasible for a number of reasons. Our problem is to find the mix of clinic visits that maximizes subsidy to patient care and does not violate any of the constraints.

Formally, we may set out the linear programming problem as follows:

Choose $CV_i$ to maximize

$$\sum \frac{SPC_i}{i} \cdot CV_i$$

Subject to

$$\sum D_i \cdot CV_i \leq DCD$$

$$\sum S_{ij} \cdot CV_i \leq SA_j$$

$$-0.25 \leq CV_i \leq 0.25 V_i$$

where

$SPC_i$ = Subsidy to patient care per visit in clinic $i$

$CV_i$ = Change in the number of visits per year to clinic $i$

$D_i$ = Deficit per additional visit to clinic $i$
DCD = Desired change in deficit in clinics considered
$S_{ij}$ = Space used in area $j$ by visit to clinic $i$
$SA_j$ = Space available in area $j$ after current use of area is taken account of
$V_i$ = Current number of visits per year to clinic $i$.

We have shown in the text how we derived $SPC_i$, and have indicated that DCD is a variable of choice (within the range of feasible solutions). The plan of the remainder of this appendix is as follows: we first show how $D_i$ was derived. $D_i$ requires data on marginal cost and marginal revenue, and we show how we found these data. We then show how $S_{ij}$ and $SA_j$ were derived, and present in detail the method used to determine the benefits from additional space.

**DERIVATION OF $D_i$: MARGINAL COST AND MARGINAL REVENUE**

We asked the heads of various clinics what change in physician staffing would result if patient loads were increased or decreased 25 percent. Although some responses may have overstated the additional physicians needed if visits increased and understated the physicians not needed if visits decreased, the responses were used as given. The marginal cost of supplies, financial interviewing, billing, cashiering, and medical records was assumed to equal their average per visit cost. Nursing costs were assumed to increase or decrease 25 percent if visits changed 25 percent; OPD and hospital administration, public health nursing, household and property, and depreciation were assumed to remain unchanged; that is, to have zero marginal cost.* In this way we obtained the marginal clinic cost of increasing or decreasing patient visits to each clinic by 25 percent.

The marginal cost of ancillary services was estimated from the short run variation in total costs that could be attributed to variation in the different types of lab and X-Ray procedures. The laboratory

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*Depreciation should have a positive marginal cost, but the cost is small enough that ignoring it does not induce any significant error.
procedures were classified into the following groups: Special, Chemistry, Urinalysis, Bacteriology, Outside Procedures, Hematology, and Serology. The X-Ray procedures were classified into the following groups: X-Ray Therapy, Special Charges, Head, Face and Neck, Spine, Skeletal, Extrema, Thoracic-Cardiac, Thoracic-Pulmonary, Abdominal, and Genito-Urinary. With sufficient data these categories can be further disaggregated. Monthly laboratory costs were then regressed upon the number of procedures in that month in each laboratory category, and a similar procedure was followed for X-Ray. This procedure understates long run marginal cost, but was felt to be the best approximation possible with the data usually available. The distribution of ancillary services among various classifications by clinic was ascertained from a sample of patient bills and the expected marginal cost of ancillary services by clinic was then calculated.

The following procedure was used to obtain estimates of marginal revenue. We estimated the free service percentage by clinic from a sample of patient bills. This was simply a weighted average of the proportion of bills written off in each pay class, the weights being the proportion of visits in each pay class in each clinic. We also computed the expected amount of bad debt in a clinic by hypothesizing that bad debt was related to bill size (net of free service) and pay class; finding the proportion of bad debt across all clinics in each of five pay classes (complete free service, of course, has no bad debt) and four bill sizes; then getting an expected value of bad debt for each clinic by looking at the distribution of patients in a clinic by pay class and bill size. In symbols:

$$BD_i = \sum_{j=1}^{4} \sum_{k=1}^{5} a_{ijk} d_{jk},$$

where $BD_i$ is the proportion of bad debt in the $i$th clinic, $a_{ijk}$ is the proportion of patients in the $i$th clinic in the $k$th pay class with the $j$th bill size, and $d_{jk}$ is the proportion

*There was substantial variation among clinics in the amount written off to Free Service in the actual data.
of bad debt across all clinics for patients in the $k^{th}$ pay class with the $j^{th}$ bill size. It was felt that this procedure would yield a better estimate of bad debt in any clinic than the actual sample bad debt in that clinic. Since bad debt is a relatively infrequent occurrence, a large sample is needed to reduce sampling error to manageable proportions. In effect, our procedure adds the a priori information that bad debt is not directly related to the disease the clinic is treating; this reduces the necessary sample somewhat.

We also needed to estimate the amount of revenue from ancillary services generated by each clinic. This also was estimated from the sample of patient bills. The estimates showed that there was a substantial variation among clinics in the usage of ancillary services, as might be expected.

To obtain expected marginal revenue by clinic, the expected proportion of the bill to be paid ($1.0 -$ the free service proportion) times the proportion of the bill that would be collected ($1.0 - BD_1$) was multiplied by the sum of the revised visit charge (that is, the market price) and the expected usage of ancillary services. In symbols, $MR_1 = (1-FS_1)(1-BD_1)(VC_1 + AC_1)$, where $MR_i =$ marginal revenue in the $i^{th}$ clinic, $FS =$ free service proportion, $VC =$ visit charge and $AC =$ ancillary service charge. The change in the deficit from an additional visit to any clinic was $MR_i - MC_1$, where $MC_1$ is the marginal cost in clinic $i$. The change in deficit from one fewer visit to clinic $i$ is $MC_1 - MR_i$.

The amount of subsidy to patient care generated by a visit to any clinic is equal to the estimated market price (including the ancillary services a private physician would order) less the expected patient revenue. The expected patient revenue is the same as the expected marginal revenue as defined above.

**DERIVATION OF SPACE REQUIREMENTS:** $D_{ij}^{kj}$ AND $SA^{kj}^{ij}$

The space requirements for a clinic visit were estimated as follows: The average number of square-foot-hours used per visit by each clinic was ascertained by determining the number of hours each clinic met,
multiplying by the number of square feet in the area in which it met, and dividing by the number of visits. With two exceptions it seemed reasonable to treat the average number of square-foot-hours as the marginal number of square-foot-hours, since the clinics in general clustered about one figure. Because of apparent excess capacity in two clinics it was assumed that they could increase visits 25 percent without requiring additional space.

It was noted that there were hours when certain areas were not in use. Using those hours we estimated the additional square-foot-hours available.

VALUE OF EXPANSION

We now show hypothetical calculations on the value of expanding certain areas of the OPD. If space were divisible so that one additional square foot would be fully utilized 2,080 hours per year (2,080 hours = 52 weeks x 40 hours/week), each additional square foot in a particular area of the OPD might reduce the annual deficit $60 and increase the annual subsidy $75. * Since each square foot of new construction costs approximately $40, in this case savings would pay for the construction in a few months. It is probable, however, that space is not perfectly divisible, and that any additional visits would require a certain minimum of extra space. The particular clinic which would be expanded with additional space may see patients at the rate of 5.0 per hour and each visit uses, say, 377 square foot hours. We then assume the clinic needs at least 377/5.0 = 75.4 additional square feet to increase visits at all. At $40/square foot, the cost of this is $3,016. 75.4 square feet generate 75.4 x 2,080 = 156,832 additional square foot hours annually. This is more than enough to increase visits in this clinic 25 percent per year and so, if no other clinic can use the space, there is excess capacity. Even so, the deficit would be reduced an additional $37,000 annually and the subsidy

*The numbers depend on the particular clinic that would be expanded if that area of the OPD were expanded.
increased $4,600. It is, therefore, worthwhile to expand this area of the OPD.*

The benefits from expanding another area may be solely in terms of subsidy. If there were more space in another particular area of the OPD, a different clinic would be expanded. Suppose, to make the most favorable assumption, space were divisible. Then suppose at the point where subsidy increase plus deficit decrease is maximized, an additional square-foot-hour of space would generate $12 in subsidy and add $3 to the deficit. In effect, the hospital spends $40 (on the square foot of space) to give itself the opportunity to buy more subsidy with a given deficit. Assuming a 5 percent interest rate and an infinite life for the building, the $12 capitalizes to $240 and the $3 to $60.** Thus, in present value terms the hospital spends $40 plus $60 to obtain a subsidy of $240, a subsidy/deficit ratio of 2.4. Depending on the size of deficit the hospital wishes to run, this may or may not be worthwhile. Other discount rates, as shown in the table below, would change this ratio.

**Hypothetical Subsidy-Deficit Ratios**

<table>
<thead>
<tr>
<th>Space</th>
<th>Discount Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5%</td>
</tr>
<tr>
<td>Divisible</td>
<td>2.4</td>
</tr>
<tr>
<td>Indivisible</td>
<td>2.3</td>
</tr>
</tbody>
</table>

*Unless the rate of discount substantially exceeds 100 percent.
**The assumption of finite, but reasonably long life would not substantially change these results.
DEFINITIONS OF VARIABLES AND THEIR INTERRELATIONSHIPS

The following definitions have been employed:

(1) $D + CL = P$ (Deficit plus value of Contributed Labor equals Philanthropy)

(2) $SPC + ST + EC = S + EC = P$ (Subsidy to Patient Care plus Subsidy to Teaching plus Excess Cost equals total Subsidy plus Excess Cost equals Philanthropy)

(3) $D = MC - TR$ (Deficit equals Market Cost of services including depreciation less Total patient Revenue)

(4) $SPC = VMP - TR$ (Subsidy to Patient Care equals the Value of the services if bought at the Market Price less actual Total patient Revenue)

(5) $ST = PCH - PCM$ (Subsidy to Teaching equals Physician Costs at Hospital less Physician Costs of the services purchased on the Market)

(6) $EC = MC + CL - ST - VMP$ (Excess Cost equals Market Cost of services plus Contributed Labor less Subsidy to Teaching less Value of the services if bought at the Market Price)

Equation (1) is the "Sources of Philanthropy" and Equation (2) is the "Uses of Philanthropy." These are constructed so as to be equal. This can be seen by substituting (4) and (6) into (2). That yields:

(7) $VMP - TR + ST + MC + CL - ST - VMP = P$

Collecting terms:

(8) $MC - TR + CL = P$

Substituting (3) into (8) yields (1).

To prove the statement on page 37 that excess costs are lowered by the sum of the change in Deficit and change in Subsidy to Patient Care less the change in Contributed Labor, substitute (3) and (4) into (6) yielding:
(9) $EC = D - SPC + CL - ST$. Since $ST$ is held constant, the change in excess costs from changing the output mix is the sum of the changes in $D$ and $CL$ less the change in $SPC$. The change in $D$ is $-20,000$, the change in $CL$ is $4,000$, and the change in $SPC$ is $65,000$, so the change in $EC$ is $-81,000$.

We assume management wishes to maximize Total Social Benefit ($TSB$) less Total Social Cost ($TSC$). The value of the marginal service to the recipient is assumed to be equal to the amount he pays for it ($MR$); the value of the marginal service to non-recipients is assumed to be equal to the subsidy given ($MS$). If we ignore distributional considerations, we can write

(10) $MSB = MR + MS$, where $MSB = \text{marginal social benefit}$.

The marginal social cost ($MSC$) of the inputs used is assumed equal to the costs paid:

(11) $MSC = MMC + MCL$, where $MMC$ and $MCL$ are the market cost and the contributed labor for the marginal service.

But since:

(12) $MCL = MP - MD = MP - (MMC - MR)$ (putting (1) and (3) in marginal terms, transposing in (1), and substituting (3)),

(13) $MSC = MP + MR$ (substituting (12) into (11) and collecting terms).

Therefore:

(14) $MSB - MSC = MS - MP = MEC = 0$ at an interior maximum (subtracting (13) from (10) and using the marginal form of (2)).

Since $P$ is given, management can maximize $TSB - TSC$ by maximizing $S$ (the criterion used in the text given that $ST$ is held constant), or it can minimize $EC$; they are equivalent. If $P$ is not given, the correct criterion is minimizing $EC$. 