AN APPROACH TO STUDYING THE COST-BEHAVIOR OF
CHANGING UTILIZATION OF A HOSPITAL LABORATORY

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I. Introduction

The recent increases in health care costs have led many to offer possible strategies for moderating the rate of growth. Ancillary services have been seen as a potentially productive target for cost containment strategies because some observers believe that a substantial portion of the utilization is unnecessary. Efforts directed toward achieving a more discerning use of ancillary services would also be consistent with an objective with which many clinicians would sympathize, a more reasoned practice of medicine.

The clinical laboratory is one aspect of ancillary services in which some cost containment strategies are being proposed and tested. In general, two different kinds of interventions have been discussed. The first set of strategies are regulatory in nature, and certificate of need control represents an example. Certificate of need is a requirement for public agency review and approval of planned expenditures by health care institutions in excess of a specified dollar amount.¹ Many states have already enacted certificate of need laws. In the clinical laboratory, these controls would potentially limit the technological capacity to perform tests. Those who espouse this kind of intervention believe that in limiting capacity, the availability of the technology will effectively be rationed, and those ordering tests will need to use clinical judgement to establish priorities for access to it. The hopeful result would be a decline in the volume of tests which are ordered.

An alternative set of strategies that have been or are being investigated in some clinical laboratories addresses directly the behavior of

practitioners who order tests.^{2,3,4,5} Recently, there have been a considerable number of reports or suggestions in the journal literature that a primary reduction in laboratory test volume has been or could be effected by means of educating practitioners in appropriate test ordering behavior, revising the reimbursement structure to reflect the need to carefully consider the number and types of tests which are ordered, or creating other incentives designed to reduce test volume.⁶

Proponents of the regulatory and behavioral approaches to contain costs in the clinical laboratory make the plausible assumption that, if a decrease in the volume of tests ordered can successfully be accomplished, a consequent decline in laboratory costs will be observed. It is of interest to be able to predict, however, the extent of the cost response to changes in test volume. A first inclination might be to determine if one would be justified in assuming that the variation is "elastic". Were that to be the case, a hypothetical ten percent reduction in the number of laboratory tests ordered would lead to a similar ten percent decline in costs incurred.* However, some refinement in the methodology will prove necessary. There will be a need to consider the fixed costs of a laboratory, which, to a first approximation, do not depend on the volume of tests performed. The problem is further complicated by the likelihood that any decrease in overall test volume would find the volumes of some tests, not necessarily the most costly ones, declining more than others. And, it would be an oversimplification, for reasons to be explained later, to use the rates at which most hospitals bill for laboratory tests to calculate cost savings that could result from declining utilization.

* It is extremely unlikely that a 10% reduction in utilization could lead to a savings of greater than 10% of costs. The theoretical possibility should, however, not be ignored.

In this paper, we describe and illustrate an approach to estimating the magnitude of cost-reduction or "cost behavior" that might be observed in response to hypothetical changes in the utilization of a clinical laboratory. We gained access to the chemistry laboratory records of a large metropolitan teaching hospital and we present the results of some preliminary calculations appropriate to that setting. We approached the problem by first deriving the actual operating costs for the entire laboratory under study and for certain functional subdivisions of that laboratory. Once this task was completed, we attempted to estimate, for purposes of illustration, the cost savings to be realized if hypothetical 20% reduction in the number of tests ordered were effected by one of the cost-containment strategies described above. We report on how our estimates of the cost-savings changed with various refinements in the assumptions about the variability of laboratory costs and volumes. Finally, we comment on the need for recognizing limitations inherent in this highly preliminary analysis.

II. Methods

A. Characteristics of the Hospital and Chemistry Laboratory

The hospital whose chemistry laboratory we used to develop and illustrate our approach is major metropolitan teaching institution having more than 500 beds. In 1977, the year for which the most complete data was available for this analysis, the hospital served more than 20,000 in-patient admissions and well in excess of 300,000 out-patients visits. In the same year, the magnitude of chemistry laboratory costs approached 1% of the total operating expenses of the hospital and chemistry revenues, a not much larger fraction of hospital revenue.

During 1977, the laboratory performed a total volume of nearly 1.3 million determinations distributed over the more than 100 different tests and procedures that were routinely offered.

The chemistry laboratory is organized into 10 rooms, each with a specialized function. Table 1 provides an overview of this functional specialization and describes, for each named room, the kinds of tests performed in each and the principal analytical instruments used. As seen in the table, the level of technology in use by the laboratory in 1977 to perform chemistry tests was typified by the dual channel continuous flow automated analyzer. The laboratory did own 4 channel continuous flow instrument which it did use to perform electrolytes, however, extensive use was not made of the multi-channel continuous flow analyzers or of the large batch analyzers during the period of our study. The laboratory also had a computer system in place that was used regularly for the storing and reporting of test results as well as other administrative functions.

As can be seen from the information described above, the laboratory operation reflects the overall philosophy of the laboratory direction and the practitioners within the hospital that the ordering of individual chemistry tests is preferable to the use of multi-test panels. The hospital represented here is one of the busiest in the country and the demands made on laboratory under study were very great. Probably unlike other laboratories serving hospitals its size, the laboratory we studied had not, by 1977, followed the trend of introducing the highly automated analyzers.

We asked the hypothetical question, "what costs savings would result if it were possible to effect a 20% decline in the volume of

tests ordered by practitioners and performed by the chemistry laboratory under study?" In order to deal with this cost behavior question, it was necessary to accurately determine test volumes and costs as they actually occurred in the laboratory.

B. Volumes

1977 chemistry laboratory tests volumes were taken from financial records of the hospital and verified using information from the laboratory instrument records. Test volume figures used in our analysis were not subjected to any of the weighting schemes which are sometimes used to report test volume figures. In the rare instances in which a test included duplicate or replicate determinations, the tests were broken down to the smallest available units and counted in that manner for consistency. Counts for a single run on the four channel continuous flow analyzer were coded to reflect the actual number of tests ordered. The growth in volume of tests performed in the laboratory 1976 to 1977 was 2%.

C. Costs

For our cost analysis, we needed to arrive at the "production function" for the chemistry laboratory as a whole and for the functionally specialized testing rooms. It would not have been valid to use laboratory test charges for the rates at which patients were billed for the tests performed. For this hospital and most others, the billing rate for laboratory tests, the so-called "charge," is paid only by patients without health insurance and by the commercial insurance carriers. State and federal hospital reimbursement programs and the Blue Cross agencies reimburse the hospitals in some proportion to actual costs which, in most instances, would be expected to be considerably lower than the billing rates.

Our approach for determining the production function for the overall laboratory depended upon the categorization of all expenses incurred by the laboratory as either supplies, general overhead, salaries, equipment, and services. Examples of the kinds of line-items provided under each expense category are as follows. Supplies include supplies for tests (93% of all supplies), personnel support supplies (6%), and office supplies (1%). Within general overhead, the building space allocation accounted for 32% of the overhead costs while the overhead in the laboratory amounted to 68%.

Salaries were those of technical (58%), administrative staff (28%), and support personnel (14%). Equipment included in instrumentation used to perform laboratory tests (84%), and general equipment used to support the laboratory such as refrigerators (16%). And finally, services included maintenance costs of equipment (11%), personnel support services (89%) such as glass washing, and contracting expenses for the performance by outside laboratories of certain tests which are not usually done in the laboratory.

In order to determine the cost response to declining laboratory utilization, it is necessary to determine which categories described above are fixed and independent of volume and which others vary in relation to volume. In order to make this tentative determination, we reviewed laboratory cost records for the years 1964-76 in addition to the detailed analysis using 1977 data. During the entire year for which detailed data was collected and analyzed, the equipment/manpower configuration of the laboratory did not significantly change.

For purposes of this preliminary analysis, the dependence of the specified categories of laboratory costs on test volume will be treated as follows. Supplies for tests are variable with respect to volume and support supplies are indirectly variable. Support supplies are variable with respect to personnel which is, in turn, are variable with respect to volume. For our analysis, the entire category of supplies will be treated as variable. Overhead expenses are considered fixed and will be treated as such in our analysis. They are assigned to the laboratory by the central hospital accounting office on the basis of floor space utilized and other considerations only peripherally related to test volume. The space requirements did not change during 1977.

Salary costs are sometimes referred to as being semi-variable with respect to volume. Voluntary hospitals are generally not known for massive layoffs of their staff and the most common means of achieving a desired reduction of level of staffing is by transfer or attrition. Salaries can realistically be considered variable in the long run. Even though a year might or might not be quite enough time to achieve a staff reduction in this manner, salaries will be treated as variable in this analysis.

Because we assumed that the equipment configuration of the laboratory did not change during the year studied, equipment costs will be treated as fixed, at the replacement value of the instruments in use. Service costs may in some instances be indirectly dependent on laboratory test volume. Under other circumstances it might have been a difficult decision as to whether to treat service costs as fixed or variable. In this instance because they will be seen to represent a rather small percentage of total laboratory costs, we make the arbitrary decision to treat service costs as fixed. Table 2 summarizes

the magnitudes of the fixed and variable costs of performing tests in the Chemistry Laboratory in 1977.

We were cognizant of the possibility that those tests contributing to the largest costs in the laboratory were not necessarily those being performed at the highest volume. In order to allow for the capability, in our analysis, of accounting for differences in rates of decline among individual tests to yield an overall twenty percent decline in laboratory test volume, if was necessary to consider the costs associated with performance of difference categories of tests. The categories of tests represented by the ten specialized laboratory workrooms represented a natural framework in which to consider costs at levels of aggregation beneath the whole laboratory. We determined the fixed and variable costs of performing tests in each of the functionally specialized laboratory work rooms as well as in the laboratory as a whole. Personnel requirements used to calculate costs of operating the various work rooms were based on actual time studies conducted in the laboratory. These were compared to and found to be generally consistent with the standard work load reporting scheme used by the College of American Pathologists.⁷ The dollar value used for an average full time equivalent member of the technical staff was estimated to be \$10,500 in 1977.

III. Discussion

Table 3 reports for each functionally specialized room, the percent of the chemistry laboratory's total volume and cost accounted for in 1977 by that room. Note that the "Autoanalyzer" room and the "Electrolyte" room are the highest ranking in both their shares of laboratory test volumes and costs. But, other test groupings contributing significantly

to test volume make relatively less of a contribution to the total costs and vice versa. For example, tests conducted in the "Odd Jobs" room account for nearly 12% of total laboratory costs and just over 2% of the total volume. Note also that over 90% of the laboratory test volume is accounted for by the tests conducted in the 5 rooms performing the highest volume.

Next, we attempt to illustrate our approach by examining the cost behavior of declining utilization of the chemistry laboratory. A hypothetical 20% decline in utilization was assumed for the sake of discussion. This assumption would not be inconsistent with the magnitude of utilization decline observed and reported in the published literature as a result of educational and administrative interventions that were used in the studies.

By way of illustration, cost savings in response to decline in test volume utilization are estimated according to three scenarios, with each succeeding scenario representing a refinement over the previous case. The first scenario is our reference case in which we assume that all costs are variable with test volume in an elastic fashion. A 20% drop in utilization across the board will, therefore, result in a 20% decline in laboratory costs. Our a priori assumption is that this scenario is not realistic, however, it is included in order to serve as a reference against which the later scenarios can be compared. Using these assumptions and the costs of performing tests in the laboratory, a cost reduction of slightly more than \$298,000 dollars would have been effected. This can also be expressed as an average saving of almost 28 full time equivalent technical personnel.*

*For illustration, dollar savings are expressed as average FTE personnel. We do not mean to suggest that the laboratory could actually reduce its staffing level by 28 persons, even if this scenario were to hold true.

The second scenario represents a refinement in the cost allocation methods in which fixed costs are tentatively differentiated from variable costs in the laboratory. Variable costs are assumed to vary linearly with test volume and the assumptions of a 20% across the board decline in test volume is used in this case as well. The assumption of linearity in the variable costs may not be realistic, however, the separate accounting for fixed and variable costs are certainly an improvement over the reference case. In this scenario, the cost-savings of a 20% decline in test volume would be reflected in a savings of 20% of the 77.4% of total laboratory costs which are variable. Using these assumptions and the actual costs of performing tests in the chemistry laboratory, the annual savings would be only about \$227,000 dollars or less than 22 full time equivalent members of the technical staff. When variable costs are differentiated from fixed costs, the annual cost savings associated with a decline in utilization is less than observed in the reference case.

In the third and final scenario we continue to assume that the average decline in the volume of laboratory tests performed is, as in the other cases 20%. However, we assume differential rates of decline among the range of tests offered in order to give this average value. We treat the tests performed in the five highest volume laboratory work "rooms" as high volume tests and assume that their rate of decline is 21.5%, while low volume tests are assumed to show no decline at all. The average volume decrease for the entire chemistry laboratory will still be approximately 20%. These high volume tests account for over 90% of the total laboratory's volume, but a lesser percent of total

costs. In this scenario, the cost savings to result from the changing utilization would derive from the variable cost avoidance of the 21.5% decline in high-volume tests ordered. Using these assumptions and the costs of performing tests in the chemistry laboratory, the cost savings is even less than among observed in the earlier cases and amounts to only \$182,000 dollars or about 17 full time equivalent technical staff members.

The results of this scenario analysis are summarized in Table 4. We have moved from the straightforward but highly unrealistic scenario of overall elastic cost decline in response to volume decrease to scenarios that represent some degree of refinement in assumptions as to the treatment of fixed and variable costs and those which differentiate tests performed in high and low volume. Our illustrative calculations suggest that in the setting we chose to study, the magnitude of the dollar savings in response to test volume decline becomes progressively smaller as these factors are accounted for. We have certainly not been able to justify or even identify all of the factors which would impact on the cost savings seen in response to a hypothetical decline in laboratory utilization. On the basis of the illustrative numbers presented above, it appears that the dollar savings associated with a hypothesized 20% decline in chemistry laboratory utilization would be at most 12.5% of dollar costs. Administrative staff of the hospital and laboratory in question have expressed their belief that any savings would, in fact, be considerably less than that.

The preliminary cost-behavior analysis described above is presented for the purpose of illustrating and discussing an approach that can potentially be used to estimate the efficacy of certain policy alternatives aimed at moderating health care costs through reductions in utilization.

This demonstration required the use of assumptions, which, in all instances are tentative and, in some cases, oversimplified. The direction of the demonstrated change in cost-savings when fixed cost and variable volume factors are accounted for is probably worthy of some confidence; certainly more than the actual numerical results of the scenario analyses presented for the laboratory we studied. Hence, it may be premature to consider the generalizability of either method or result to laboratories in other institutions having different size, organization, and operating philosophy.

References

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<u>SPECIALIZED LABORATORY "ROOM"</u>	<u>EXAMPLES OF MAJOR TESTS PERFORMED</u>	<u>REPRESENTATIVE ANALYTICAL INSTRUMENT</u>
1. "Autonalyzer"	BUN, Glucose, Creatinine, Calcium	Dual Channel Continuous Flow Analyzer
2. "Electrolyte"	Sodium, Potassium, Chloride	Four Channel Continuous Flow Analyzer
3. "Liver Function"	Bilirubin, Albumin, Amylase	Spectrophotometer
4. "LKB"	IDH, SGOT	Enzyme Analyzer
5. "Iron"	Iron, TIBC, CPK, Thyroxine	Continuous Flow Analyzer
6. "Odd Job"	Ammonia, Fibrinogen, Barbiturates, Isozymes	pH-meter, spectrometer, fluorometer
7. "Cholesterol"	Cholesterol, Triglycerdos	Dual channel continuous Flow Analyzer
8. "Steroid"	17-OH-Steroids, VMA, Magnesium	Spectrophotometer
9. "Electrophoresis"	Protein Electrophoresus, 5 - Nucleotidase	Electrophoresis unit
10. "GLC"	Diphenylhydantoin	Gas-Liquid chromatograph

Table 1. Organization of the Chemistry Laboratory according to "Rooms" performing specialized function. Examples of representative tests and analytical instruments used in each room.

	<u>% of Total Laboratory Costs</u>
Fixed Costs	
Equipment	4.1%
Overhead	16.0
<u>Services</u>	<u>2.6</u>
Total Fixed Costs	22.6%
Variable Costs	
Supply Costs	15.0%
<u>Salaries</u>	<u>62.4</u>
Total Variable	77.4%

TABLE 2. Fixed and Variable Costs of Performing Tests in the Chemistry Laboratory in 1977.

<u>Functional Work "Room"</u>	<u>% Total Volume</u>	<u>% Total Costs</u>
"Autoanalyzer"	37.5%	29.6%
"Electrolyte"	32.3	22.4
"Liver Function"	12.0	11.0
"LKB"	7.8	5.0
"Iron"	3.5	5.9
"Odd Job"	2.3	11.9
"Cholesterol"	2.1	3.2
"Steroid "	1.5	5.6
"Electrophoresis "	0.6	2.7
"GLC "	0.4	2.7

Total Chemistry Laboratory	100%	100%

TABLE 3 Percent of Total Laboratory Volumes and Costs Accounted for
by Each Functional Work Room

<u>CASE</u>	<u>OVERALL</u>	<u>ASSUMED DECLINE IN TEST VOLUME</u>		<u>FIXED AND VARIABLE COSTS DIFFERENTIATED</u>	<u>RESULTING COST-SAVINGS</u>	
		<u>HIGH VOLUME TESTS</u>	<u>LOW VOLUME TESTS</u>		<u>DOLLARS</u>	<u>FTE TECHNICAL STAFF</u>
I	20%	20%	20%	NO	\$290,000	28
II	20%	20%	20%	YES	\$227,000	22
III	20%	21.5%	0%	YES	\$182,000	17

TABLE 4. Illustration of Approach to Studying Cost-Behavior of Declining Laboratory Utilization. Consideration of 3 Alternative Cases Reflecting a Hypothetical 20% Decline in Test Volume