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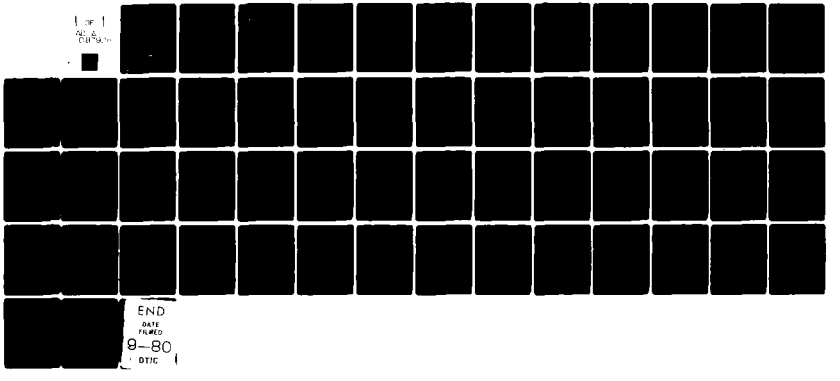

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THE HEALTH CARE UNIT:

A NEW APPROACH

TO MILITARY HOSPITAL PRODUCT MEASUREMENT

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JUNE 1980

FINAL REPORT

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For the past 24 years the Dept of Defense has used the Composite Work Unit (CWU) as a measure of the output of military hospitals. With the advent of the Uniform Chart of Accounts (UCA), a new standardized accounting system used by all DOD hospitals, a more sophisticated measure can be supported. The Health Care Unit is designed as such a measure of hospital output which takes advantage of the plethora of data now available. It is essentially a weighted sum of the performance factors generated within each of the 19 final accounts of

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20. Abstract (continued)

the UCA, in which the weights themselves are derivable from post system-wide UCA data. A complete description of the methodology used in deriving the weights is included. The report concludes with suggestions for several potential modifications and extensions of the concept into the areas of resource allocation models and management information systems.

THE HEALTH CARE UNIT:
A NEW APPROACH TO
MILITARY HOSPITAL PRODUCT MEASUREMENT

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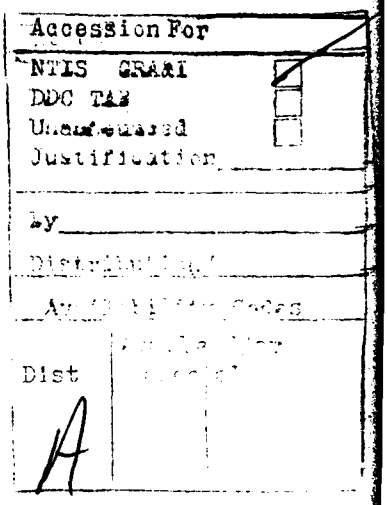

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Chapter 1
INTRODUCTION

The Department of Defense spends billions of dollars each year to support the operation of the Military Health Care System. The very size of this expenditure, apart from the obvious importance of maintaining a healthy fighting force, establishes the need for a product measure which accurately portrays the output of military hospitals. Such information can be useful in comparing the performances of individual Medical Treatment Facilities within specified peer groups and also in tracking an individual facility over time. Additionally, such a measure could be used as an input to fiscal and manpower resource allocation models, along with other factors such as facility size, type, local wage rate and so on. We emphasize, however, that no measure of hospital output, however sophisticated, should be used exclusively in allocating resources.

Until now, a lack of uniformly reported cost and performance data has inhibited the development of an accurate output measure. But with the advent of the Uniform Chart of Accounts (UCA), the door has been opened to the possibility of obtaining such a measure. In this report, we have formulated a new approach to assessing the output of the military hospital--the Health Care Unit (HCU).

In Chapter 2 the need for a new approach will be demonstrated by tracing the history of hospital product measures and noting the areas in which they have proven to be lacking. Next, Chapter 3 identifies and discusses those characteristics which a hospital product measure should possess to be effective and useful in managing the hospital system. The general concept of the Health Care Unit is first set forth in Chapter 4 along with its relationship to the DOD Medical Expense and Performance Report (MEPR).

Several different methods for weighting the various services which the hospital performs are presented in Chapter 5, and in

Chapter 6 one particular approach is presented which, on the basis of existing data, appears to be the best choice for implementation. Concluding remarks are contained in Chapter 7.

Throughout the report, actual data from nine* of the ten hospitals which participated in the two-year initial test of the Uniform Chart of Accounts have been used, thereby injecting a considerable degree of realism into this effort. The identities of these hospitals, however, have not been disclosed.

*The tenth was not included because a complete set of data from this facility was not available to the authors.

Chapter 2
THE NEED FOR A NEW PRODUCT MEASURE

Any organization working with a limited amount of resources needs a method for measuring its output in order to assess overall performance. In some cases the choice is clear. For example, in a manufacturing firm the measure of output is simply the number and type of items produced. Measuring the product of a hospital, and to some extent any service organization, is far more complex because it is difficult to agree on just what the product really is. Some have contended that the hospital's product is the general health of the population it serves while others have suggested that it is the improvement in health of the patients it actually treats. The difficulty in quantifying these approaches has led the services to use "health care delivered" as the measure of their hospitals' output, although from time to time the precise definition of that phrase has changed somewhat.

Prior to 1956 occupied bed days was used as the indicator of hospital product. The Surgeons General of the armed services, together with the Department of Defense and the Bureau of the Budget, questioned the validity of this method as a measure of product. As a result, a tri-service study of 34 CONUS hospitals was undertaken in October 1956. The study resulted in the introduction of the Composite Work Unit (CWU), which is calculated in the following manner:

$$\text{Nr. of CWUs} = OB + 10\,AD + 10\,LB + 0.30\,CV$$

where

OB = Average Daily Occupied Beds
AD = Average Daily Admissions
LB = Average Daily Live Births
CV = Average Daily Clinic Visits

The CWU was designed to improve upon occupied bed days as a product measure by using occupied beds as a standard and relating the other variables to the bed day. Thus an attempt was made to

account for workload variation brought about by different lengths of stay and varying numbers of live births and clinic visits.

The CWU has come under criticism since its inception, largely resulting from its continued use in applications for which it was never intended. It is not reasonable to expect that a weighted sum of four variables, whose weights were developed 24 years ago, should be both the primary indicator of hospital output and a major determinant in the allocation of manpower and monetary resources. Nor whould it be expected that this rather coarse measure would be useful at all levels of management from the individual hospital to OSD and OMB. Yet the very fact that this is attempted demonstrates the need which managers at all levels have for high-quality quantitative measures of hospital outputs.

The Air Force developed a me[illegible] that they believed would more accurately reflect the output of their hospitals. Called the Adjusted Admission Equivalent (AAE), it is calculated as follows:

$$\text{Nr. of AAEs} = AD + .015\,CV + .016\,DP + .003\,LP + .003\,PR + .004\,XR$$

where

AD = Number of Admissions
CV = Number of Clinic Visits
DP = Number of Dental Procedures
LP = Number of Laboratory Procedures
PR = Number of Prescriptions
XR = Number of X-Rays

It was proposed that this measure be used in place of the CWU to support fiscal appropriations and apportionments for its hospitals*. This proposal was not accepted by OSD and so the

*The Army-sponsored MECCUS Study noted that "the Adjusted Admission Equivalent system does not appear desirable for use since it does not consider the variable of 'beds occupied',..., the factor accounting for the greatest percent of the variance,..."

Air Force currently records CWUs for external use but still computes AAEs for its own internal use.

Thus the two measures currently in use by the services are both weighted sums of a small number of variables. Furthermore, the weights were determined once and for all as the result of studies, and continue to provide a source of disagreement concerning their validity and usefulness.

To a large degree, the use of such a small number of variables and fixed weights appears to be a result of a paucity of uniformly reported data. Fortunately this constraint appears to have been eliminated. In response to the Military Health Care Study recommendations, a Uniform Chart of Accounts has been developed which will be used by all military hospitals beginning in FY80. This accounting procedure, though perhaps not the ultimate, should be able to support a truly sophisticated measure of hospital output, and has been used in the development of the Health Care Unit.

Chapter 3
CHARACTERISTICS DESIRED IN A NEW PRODUCT MEASURE

Introduction

In considering the characteristics desired in a measure of hospital product, one must first decide the general approach to be taken. Is the state of health of the hospital's beneficiary population to be measured or is it the amount of health care which the hospital actually delivers? While an excellent case can be made for the fact that improved population health is indeed the goal of the hospital, historically the quantity of health care delivered has been the generally accepted measure of performance for both military and civilian hospitals. We have chosen to follow this course in the development of the Health Care Unit.

Having selected this overall approach, there are still many alternatives available in the formulation of a specific measure. As an aid to choosing among them, we have identified a number of seemingly desirable characteristics for a product measure; they are listed and discussed in the next section. The quality of a potential product measure can then be gauged by the degree to which it possesses them.

Specific Characteristics

Expressible as a Single Number

There is sometimes a tendency to insist that the various services provided by a hospital are so diverse that they cannot reasonably be related to one another through a common measure, and that they should therefore be reported separately by category of service. While it is true that comparing the value of hospital services is not an easy task, it must be done if the overall output of the hospital is to be understood by and useful to managers at higher levels in the organization. Therefore the product measure should be expressible as a single number.

Not Adjusted for Facility Type

Similar services performed at different hospitals should result in the same measure of output, even if there are differences in the size and location of the facilities. If the efficiencies (as opposed to the products) of hospitals are to be compared, then issues such as economy of scale, location and local wage rate must be taken into account through peer grouping or other techniques, but the output measure should reflect exactly what health care was delivered without adjustment.

Minimal Use of Proxies

To some degree, any choice of an output measure will be a proxy for the health care which is actually delivered. But to be most meaningful and reliable, the measure should be as closely related as possible to what is being measured.

Use of Existing Data Bases

Based upon our discussions with numerous managers and administrative personnel throughout the military health care community, we concluded that a major problem in collecting data is in assuring that providers record accurately the services they have provided. For this and obvious budgetary reasons, a new product measure should use existing data bases to the greatest degree possible. Any additional data collection which might be required should take place within the existing organizational framework and reporting system.

Adaptability

A major criticism of both the CWU and the AAE has been that they do not take advantage of new information as it becomes available. Based on the assumption that any new measure will use the UCA, that measure should be flexible enough to incorporate the changes which will most likely take place in the UCA data collection and reporting system. In addition to changes in the existing UCA, there will probably be additional information reported under it stemming from changes in hospital organization

or changes in the practice of medicine. The output measure should be able to adapt to these changes and continue to reflect the services being provided. The desire for adaptability must, however, be moderated by the need to keep the measure sufficiently stable so that comparisons over time may be made, and also so that the original thrust of the system is not altered.

Avoid Measuring Quality of Care

Although quality of care is of paramount importance in all hospitals and therefore must be closely monitored, the output measure is not the place to do it. The assumption should be made that all care meets or exceeds accepted standards and that all procedures performed are required. The output measure, then, should reflect only the quantity of care actually delivered, leaving quality assurance issues to other systems.

Useful at All Organizational Levels

The importance of accurate and timely measures of the output of military hospitals at the OSD and OMB level are obvious. Also of great importance, however, is a measure which has an appropriate level of detail to be useful at the service level, the hospital level, and even at the clinic level within the hospital. For it is at these levels where a knowledge of output, and thereby of efficiency, may result in changes of day-to-day procedures which can reduce costs and boost performance.

Chapter 4
THE HEALTH CARE UNIT CONCEPT

Introduction

In developing a product measure for a hospital, it is necessary to find a meaningful way to reflect its many and diverse outputs in terms of a single number. In a very real sense every treatment provided a patient is unique, requiring varying combinations and amounts of the hospital's personnel and capital resources, and should therefore result in a distinct "credit" in the hospital's overall output. From a practical point of view, however, pursuing such a fine grain approach is clearly infeasible; even if it were, the necessary accounting procedure would undoubtedly cost more than it would be worth. In light of this, our approach to formulating a product measure will be first to partition the totality of types of direct patient care produced by a hospital into reasonably homogeneous categories. Next, the number of treatments within each category will be tallied and finally a weighted sum (where the weights are determined by ascertaining the relative "values" of the different treatments) will be computed which will be the product measure for the hospital.

Partitioning for Homogeneity

Numerous possibilities exist for partitioning hospital output into reasonably homogeneous categories. For example, at the coarsest level we would want to distinguish between outpatient visits and admissions by placing them in separate categories. But we might also wish to distinguish between different types of outpatient visits by counting the visits to each different clinic separately. And even within a particular clinic, it might be reasonable to count the number of cases of a certain type which were treated. Additionally, we might wish to distinguish between admissions in a similar manner. Clearly, the finer grain the category, the more homogeneous will be the types of treatment

provided within that category. A fine grain approach is not without its problems, however. The larger the number of distinct categories we choose, the more complicated the problem of determining the weights--the relative value of a service provided in one category with respect to a service in another--which will be necessary to compute a single overall product measure for the hospital.

Adjusting for Intensity of Care

Even after partitioning the output of the hospital into homogeneous categories, some differences in case-mix (and consequently the intensity of care required) are certain to exist within each category. Depending upon both the particular grouping chosen and the accuracy desired, it may or may not be necessary to adjust the reported output to reflect these differences. If the partitioning is coarse, making adjustments assumes greater importance. Likewise, if greater accuracy is needed, adjustments should be made. It would appear that an application of the Diagnostic Related Group (DRG) concept might be used to account for differences in intensity of care resulting from different case-mixes, should it prove necessary to make adjustments in the output.

Data Limitations

Although in principle the category partitioning may be as coarse or as fine as desired, in practice the degree of fineness is limited by the form in which the hospitals report their cost and performance data. Additionally, if the "weights" (to be discussed later) are chosen in some way external to the hospital reporting system, then the partitioning must reflect data limitations in those areas as well.

The Uniform Chart of Accounts initially reports cost and performance data for direct patient care in more than a hundred "three-letter" final accounts. This information is then

aggregated into six Inpatient Care accounts, eleven Ambulatory Care accounts, and two Dental Care accounts which is reported in the Medical Expense and Performance Report (MEPR). This degree of fineness of partitioning appears to be generally about right for use in formulating a hospital product measure, although should it be found desirable to do so, the unaggregated data could be used, resulting in a much finer partition. This could be of great help in dealing with the case-mix issue. Alternatively, an intermediate position could be taken wherein some, but not all, accounts are aggregated. One very reasonable possibility along this line would be to use the MEPR data essentially as is, with the exception of splitting out the Intensive Care Unit (ICU) and Coronary Care Unit (CCU) accounts

At the present time, the only performance units reported in the UCA which are weighted to reflect intensity of care are the dental procedures. So, for example, all visits to an Internal Medicine Clinic are counted the same. Thus the only feasible approach to addressing case-mix issues at the moment is through partitioning. Also, no performance units at all are reported for Special Programs, so these services provided by hospitals cannot presently be included in an output measure.

Finally, the accuracy of the product measure can be no greater than that of the data used in its computation, and currently the accuracy of the UCA data appears open to question. This is not particularly surprising, since the recent conversion from the previous accounting systems was a massive undertaking. It seems quite likely that after its first full year of operation, the birth pains will have subsided and the data will achieve a high degree of reliability.

The General Concept

Although some of the suggestions discussed above could be incorporated at a later date, we shall define our hospital product

measure to be a linear combination, or weighted sum, of the 25 performance factors which are reported in Part I of the Medical Expense and Performance Report (see Table 1).

Inpatient Care Dispositions	Ambulatory Care Visits (Outpatient and Inpatient)
1. Medical	13. Medical
2. Surgical	14. Surgical
3. Obstetrical/Gynecological	15. Obstetrical/Gynecological
4. Pediatric	16. Pediatric
5. Orthopedic	17. Orthopedic
6. Psychiatric	18. Psychiatric/Mental Health
	19. Family Practice
	20. Primary Medical
Inpatient Care Occupied Bed Days	21. Emergency Medical
	22. Flight Medicine
7. Medical	23. Undersea Medicine
8. Surgical	
9. Obstetrical/Gynecological	Dental Care Weighted Dental Procedures
10. Pediatric	
11. Orthopedic	24. Dental Services
12. Psychiatric	25. Dental Laboratories

Table 1. Performance Factors

We shall use the numbering system in this table throughout the remainder of the paper. To begin the mathematical formulation of the product measure, let

P_i $(i = 1,2,\ldots,25)$ be the number of performance factors of category i, and let

W_i $(i = 1,2,\ldots,25)$ be the weighting factor associated with category i

For example, $P_4 = 273$ means that in Account #4 in Table 1, there are 273 Pediatric Inpatient Care Dispositions, and similarly, $P_{14} = 961$ means that there are a total of 961 outpatient and inpatient visits to the Surgical Care Clinic.

Using this notation, the hospital product measure is defined to be:

$$W_1P_1 + W_2P_2 + W_3P_3 + \ldots + W_{25}P_{25}$$

Of course the really critical issue is that of determining the weights, which indicate the relative value of a performance factor of one type with that of another. The choice of weights will also determine the magnitude of the product measure as well as the units in which it is expressed. The next chapter is devoted to a careful treatment of this question.

Chapter 5
APPROACHES TO WEIGHTING

Introduction

The essential purpose of the weights is to determine the relative value of each of the 25 final account performance factors so that a single overall product measure for the hospital may be determined. Thus a system of weights will, for example, relate the value of a pediatric outpatient visit to an occupied bed day in the surgery ward. This is not an easy task. Note that there is no single "correct" answer to the problem; the criteria for acceptance must be those of inherent reasonableness and usefulness.

First of all, measures which attempt to quantify the patient's general health and well being have been ruled out. We have also ruled out weights based upon management engineering standards because all the required data simply are not available at the present time, nor are they likely ever to be available.

In the remainder of this chapter we shall discuss the alternatives which are available in dealing with these and other issues. Throughout this discussion we will use cost as the basis for determining the relative weights associated with each final account. Even though there are some problems in this approach (costs will become inflated over time, for example), they do not appear to be insurmountable. In fact, there are two very real advantages. First, all input resources can ultimately be expressed as costs--manpower, equipment, facilities, etc. And second, appropriate cost data is abundantly available in the UCA.

Data for Determining Weights

Internal Cost Data Approach

In this approach to establishing relative weights of hospital services, we take the value of a given unit of output to be the amount which the government, on the average, actually pays for it. To use the example of pediatric outpatient visits again, the

value of a single such visit would be determined by the cost, DOD-wide, of a visit to the Pediatric Clinic. Four possible approaches to computing these "average" costs from data contained in the MEPRs are presented below. In all cases, a separate computation is made for each of the 25 performance factors and is designated W_i $(i = 1,2,\ldots,25)$.

1. Overall average. The total DOD-wide cost is divided by the sum of the performance factors generated in all DOD hospitals. The resulting numbers, then, are the average costs per performance factor and are used as the weights.

2. Mean by hospital. The average cost per performance factor is calculated for each hospital. Then these averages are themselves averaged. The resulting number is taken to be the weight.

3. Mean by hospital adjusted for extremes. As in 2 above, the average cost per performance factor is calculated for each hospital. These averages are themselves averaged and a standard deviation is computed. Those numbers which are more than a specified number of standard deviations from the mean are discarded and the remaining numbers are again averaged to obtain the weight.

4. Median by hospital. As in 2 above, the average cost per performance factor is calculated for each hospital. Then the median value (the "middle" number when arranged in order) is identified and used as the weight.

External Cost Data Approach

Another method for determining the relative weights for each of the accounts is to assume the value of each service provided in the military hospital corresponds directly to the average cost for a corresponding service in a civilian hospital. This cost information could probably be obtained from a variety of sources. Thus it would be necessary to identify such costs with each of the 25 performance factors previously referred to.

This task appears reasonably straightforward although some problems would surely be encountered in identifying comparable services. It would be most surprising, for example, if there were corresponding costs for Flight Medicine and Undersea Medicine Clinic visits, Categories 22 and 23 respectively. This cost data

would have to be obtained by analogy with other categories of clinic visits. While comparable services exist in civilian hospitals for each of the six categories of inpatient care, accounting procedures would have to be examined carefully and adjusted where necessary. As an example, physician charges are normally billed separately in civilian hospitals, so these would have to be correlated with the hospital charges before average costs per disposition and average costs per occupied bed days could be computed.

While there is some appeal to using a system of weights developed from data external to the system for which the measure would be used, the task appears formidable and probably would never be completely satisfactory.

Weights for Inpatient Care

Because of the fact that two distinct performance factors (dispositions and occupied bed days) are associated with each of the six categories of inpatient care, steps must be taken to avoid counting this output twice. The following five approaches all appear to be viable candidates.

Dispositions Methods

In this method, $W_7, W_8, \ldots, W_{12}$ are all set equal to zero so that the inpatient care is credited to hospital output solely by the number of inpatient care dispositions, without regard to the number of occupied bed days.

Occupied Bed Day Method

In the method, $W_1, W_2, \ldots, W_6$ are all set equal to zero so that the inpatient care is credited to hospital output solely by the number of inpatient care occupied bed days, without regard to the number of dispositions.

Direct Regression Method

In this method, the output for each of the six categories of inpatient care is taken to be a weighted sum of the dispositions

and occupied bed days for each category, where the weights are obtained by regressing those variables against the expense incurred in each category. Details on this method are contained in Appendix B.

Indirect Regression Method

In this method, the outputs using both Method 1 and Method 2 above are first obtained. Then the final output is taken to be that convex linear combination of these two outputs which best explain the variation in expense from hospital to hospital. Details on this method are also contained in Appendix B.

Length of Stay Regression Method

In this method, average length of stay is regressed against average cost per disposition for each of the six inpatient accounts. The intercept of the regression line is taken to be the weight associated with the number of dispositions for that account while the slope determines the weight associated with the number of bed days. See Appendix B for details.

Periodic Updating of Weights

The weights associated with the Composite Work Unit (CWU) have changed only once since its initial formulation in 1956. This is not particularly surprising, since there is nothing in the process of calculating the number of CWUs generated each year which would naturally lead to a revision of the weights; a study must be initiated each time a revision is thought necessary. In sharp contrast, with the product measure described in this paper, the weights may be recalculated as often as desired to reflect changes in the practice of medicine which alter the relative intensity of service provided in each account. In fact, it is so easy to recalculate the weights that a conscious decision must be made to determine how often is most desirable.

While frequent revision ensures that the weights do indeed reflect changing levels of relative productivity among the various

accounts, it is accomplished at the expense of being able to compare changes in overall output for a given hospital over time. Computing the weights for a "base year" and holding them constant solves that problem, but only at the expense of being able to reflect changes in the practice of medicine. One intermediate position is to use smoothing techniques, two of which will be briefly discussed below. Another is to update at periodic intervals--3 to 5 years, perhaps.

In any case, if the weights are updated at all, they should be adjusted for inflation so that greater output is not indicated solely because of inflated weights. We shall consider the following four approaches to updating the weights, examples of which are contained in Appendix A.

Continual Update

Each year, all the weights are recomputed using the cost information in the current MEPRs. Recomputation should not be done more often than once a year in order to avoid seasonal fluctuation.

Base Year

The weights are calculated for a base year, perhaps FY80 (the first year in which all DOD hospitals employ the UCA), and are used until the decision is made to change the base year.

Cumulative

The weights are recalculated each quarter, but are based on the costs and performance factors generated in the previous n quarters, where n should probably be chosen to be somewhere in the range of 4, 8 or 12. This allows the weights to change, but provides a considerable amount of smoothing to damp out the inevitable quarter-to-quarter fluctuations. By insuring that the number of quarters chosen is divisible by four, seasonal fluctuations will not be a problem.

Exponential Smoothing

This approach calculates current weights each quarter and combines them with the weights used during the preceding quarter to obtain new weights, thereby providing a damping effect. The formulas used along with a complete explanation of this process are in Appendix A.

Output Units

In everything which has been discussed up to this point, no mention has been made of the units in which the proposed product measure is to be expressed. In fact, the careful reader will probably have noticed that the Health Care Unit per se has not really been defined, except to give the formula for hospital output as

$$\text{Number of HCUs} = W_1P_1 + W_2P_2 + W_3P_3 + \ldots + W_{25}P_{25}$$

where the weights $W_1, W_2, W_3, \ldots, W_{25}$ can be defined in a variety of ways. Clearly, then, the definition given to the weights (and their units) will in turn determine the exact definition given to the HCU and its units.

Four different potential output units, with corresponding definitions of the HCU, are listed below. In each case we assume that the weights $W_1, W_2, W_3, \ldots, W_{25}$ are expressed initially in dollars per performance unit. The way in which the weights are then modified will determine the actual units of the product measure.

Value of Care in Dollars

If the weights are just left exactly as they are, then the output units of the product measure will be dollars. Note that even though dollars are used as a unit of input to the health care system, reflecting expense, it is not unreasonable to use the same units for the output as well, since here they reflect the value of care delivered. Accordingly, the HCU is defined to be that amount of care which has a value of one dollar, or more simply, one dollar's worth of care.

Equivalent Performance Factor

In this approach, the output is expressed in terms of one of the 25 performance factors by dividing through by the associated weight. For example, if the total output

$$W_1P_1 + W_2P_2 + \ldots + W_{25}P_{25}$$

is divided by W_1, we obtain

$$P_1 + \frac{W_2}{W_1} P_2 + \ldots + \frac{W_{25}}{W_1} P_{25}$$

which expresses the total hospital output in terms of "equivalent Medical Care Dispositions," the units of category 1 (see Table 1).

A word of explanation is surely in order concerning how this division by W_1 actually achieves the desired results. The units of the first term, P_1, are medical care dispositions. Now we consider the second term. Since the units of W_1 are dollars per medical care disposition and the units of W_2 are dollars per surgical care disposition, the units of the quotient W_2/W_1 are medical care dispositions per surgical care disposition. Then when W_2/W_1 is multiplied by P_2, whose units are surgical care dispositions, the units of the product are "medical care dispositions." Thus we have related the actual surgical care dispositions into equivalent medical care dispositions. Exactly the same reasoning applies to the remaining 23 terms in the expression.

Clearly the output could be expressed in terms of any one of the 25 performance factors that would be desired by dividing through the original product measure by the corresponding weight.

Combined Performance Factors

Here the output is not expressed in terms of any <u>one</u> of the 25 performance factors, but rather a combination of several of them. For example, the output could be expressed in terms of equivalent dispositions by calculating a combined weighting factor W_{dp} in the following manner:

$$W_{dp} = \frac{\text{Total Cost (DOD-wide) of Inpatient Care}}{\text{Total Number (DOD-wide) of Dispositions}}$$

Then the total output is divided by W_{dp} to obtain

$$\frac{W_1}{W_{dp}} P_1 + \frac{W_2}{W_{dp}} P_2 + \ldots + \frac{W_{25}}{W_{dp}} P_{25}$$

Other output units, such as equivalent occupied bed days, could be used as well by calculating the appropriate weighting factor.

External Factors

With this method, the output is expressed in units which are completely external to the UCA system. For example, output could be expressed in terms of equivalent patient days of care in a civilian hospital, by dividing the output by the average cost per patient day in a civilian hospital, W_{pd}. In this case the product measure would be:

$$\frac{W_1}{W_{pd}} P_1 + \frac{W_2}{W_{pd}} P_2 + \ldots + \frac{W_{25}}{W_{pd}} P_{25}$$

Summary

From the preceding discussion we see that there is a great deal of flexibility in choosing an overall weighting methodology which in turn will define the Health Care Unit. So much so, in fact, that the whole issue may seem somewhat confusing. Essentially, the process of selecting a particular specific definition for the Health Care Unit involves making a choice of a particular method in each of the four areas discussed above, assuming that the internal cost data approach is taken. (If external cost data is used, choices need be made only in the last three areas.) For easy reference, the areas, along with the possible methods which could be used in each, are listed below.

- Cost Averaging
  - Overall average
  - Mean by hospital
  - Mean by hospital adjusted
  - Median by hospital

- Periodic Updating
  - Continual update
  - Base year
  - Cumulative
  - Exponential smoothing

- Weights for Inpatient Care
  - Dispositions method
  - Occupied bed day method
  - Direct regression method
  - Indirect regression method
  - Length of stay regression method

- Output Units
  - Value of care in dollars
  - Equivalent performance factor
  - Combined performance factor
  - External factor

Chapter 6
THE HEALTH CARE UNIT RECOMMENDED APPROACH

Introduction

Having laid the ground work for the Health Care Unit in the preceding chapters, we now present our recommendation for the specific form it should take, i.e., the options which should be chosen for determining the weights. This has been accomplished after extensive discussions with the potential users of the system as well as painstaking examination of the data which is available from the nine hospitals participating in the UCA test program. Note that what is being recommended is the specific methodology for determining the weights--not the weights themselves. They should be calculated, using the methodology, from the FY80 UCA data from the worldwide system of military hospitals. If it turns out that this data is either not completely available or appears to be of questionable validity because of the newness of the system, consideration should be given to thinking of the resulting weights as provisional in nature and using FY81 data for a "final" determination of the weights.

The recommended weighting options are:

- Data for determining weights--mean costs adjusted for extremes.
- Weights for inpatient care--length of stay regression method.
- Periodic updating of weights--base year.
- Output units--combined performance factor (equivalent dispositions).

The sample calculations which are contained in the remainder of this chapter use the UCA test data and are provided to illustrate the recommended methods.

FACTOR #	HOSP #1	HOSP #2	HOSP #3	HOSP #4	HOSP #5	HOSP #6	HOSP #7	HOSP #8	HOSP #9	WEIGHT
1	735.21	2240.82*	1256.93	1119.61	1336.81	1053.95	644.42	1497.55	1251.28	1111.97
2	950.49	1261.25	1422.67	1130.93	860.97	1614.32	1228.97	1222.12	1624.06	1257.31
3	833.52	1003.97	1075.66	884.53	871.42	920.51	1590.83*	921.42	813.11	915.52
4	1590.38	2122.29*	721.82	593.10	466.36	488.97	407.05	811.85	751.82	728.92
5	1192.82	810.29	2140.00*	1291.38	997.03	1445.27	1737.35	1588.61	1154.39	1277.14
6	74.83	2349.17	947.61	1152.22	623.17	1766.08	0.00	1640.15	2038.97	1176.91
7	172.06	139.71	225.24	195.72	252.47	127.56	153.68	168.55	146.52	175.72
8	280.41	132.41	308.33	240.23	237.34	341.78	217.10	170.00	193.66	235.69
9	239.19	176.32	271.69	240.48	261.23	264.44	189.99	210.15	222.56	230.67
10	165.06	146.89	195.31	148.72	136.91	139.29	159.61	184.14	149.44	160.60
11	201.00	58.54	285.33	151.63	199.73	241.56	119.84	146.66	109.17	168.16
12	89.80	49.28	153.57	88.34	373.90*	171.60	0.00	76.40	65.74	86.84
13	14.28	44.03*	22.96	14.60	30.95	17.69	17.64	29.53	22.06	21.21
14	21.87	56.23*	42.84	25.86	30.88	24.03	24.72	25.51	27.96	27.96
15	21.97	10.95	20.41	12.21	15.40	26.20	29.51	17.26	22.69	19.62
16	16.61	84.17*		13.02	15.80	35.64	15.70	15.14	13.06	17.85
17	31.54	63.11	57.87	11.01	35.25	18.22	15.38	27.60	27.03	31.89
18	13.03	97.74*	13.77	9.38	25.61	33.66	43.30	20.79	17.26	22.10
19				23.08		30.05	19.49	37.09		27.43
20	12.07	10.55	28.38	18.13	25.82	12.70	16.03	18.04	32.03	19.31
21	23.35	19.47	38.81	55.76*	18.37	23.04	21.75	24.21	16.69	23.21
22	25.72		36.92			26.23	32.99	35.35	6.02*	31.44
23					5.55					5.55
24	5.29		5.43	10.59	41.98*	12.53	5.01	5.00	5.71	7.08
25	0.51		2.10	3.12			0.96	1.96	2.15	1.80

Table 2. FY79-1 Mean Costs

Computing the Weights

Mean Costs Adjusted for Extremes

The expense reported in each final account at each hospital is divided by the corresponding performance factor to obtain a cost per performance factor. (Inpatient weights have been calculated in this way for illustration purposes, but these values will not be used since the length of stay regression will determine them in a different way.) The numbers obtained from each are placed in order by final account and a mean and standard deviation is computed for each account. Numbers which deviate from the mean by more than two standard deviations are removed and the remaining numbers are averaged again. The resulting value is taken to be the weight for that account. The actual numbers generated from the first quarter FY79 data at the nine UCA test hospitals are depicted in Table 2. The 25 factor numbers refer to those in Table 1. The asterisks indicate numbers which were more than two standard deviations from the mean.

Length of Stay Regression Method

For each final inpatient account in each hospital, the average length of stay is computed by dividing the number of bed days by the number of dispositions. The cost per disposition is also calculated. These pairs of points are plotted for each inpatient account and a least squares fit is accomplished. The point at which the regression line intercepts the vertical axis is the weight for dispositions while the slope is the weight for bed days (see Figures B1-B6 in Appendix B). The weights calculated for the inpatient accounts based on the test data are contained in Table 3.

Inpatient Account	Disposition Weights	Occupied Bed Day Weights
1. Medical	416.2	108.7
2. Surgical	404.5	163.6
3. Obstetrical/Gynecological	375.3	132.0
4. Pediatric	87.0	143.7
5. Orthopedic	1080.0	29.1
6. Psychiatric	825.2	48.3

Table 3. Inpatient Weights

Base Year

No automatic updating of the weights is recommended. However, at three to five year intervals, the weights should be recomputed to determine if shifts in the relative value of services performed have occurred. At that point it can be decided by the users whether or not the weights have changed sufficiently to justify using the new values.

Equivalent Dispositions

The average cost per disposition in the entire DOD system is computed by dividing the total cost of inpatient care by the total number of dispositions. Then each weight previously computed is divided by this number to obtain a set of modified weights which when multiplied by the appropriate performance factors will yield the number of equivalent dispositions generated. Using the test hospital data, the average cost per disposition in FY79-1 is $1129.89. Table 4 summarizes the original and modified weights associated with each of the 25 performance factors.

Computing the Health Care Units

With the weights determined, the task of computing the number of Health Care Units produced by a hospital in a specified period of time is very straightforward--merely multiply the number of performance factors produced in each final account by the corresponding weights and add the resulting products. This has been done for "Hospital #4" of the nine test hospitals for Quarter 1 of FY79. These numbers have been added to the MEPR in Table 5.

Performance Factor	Original Weight	Modified Weight
1. Medical Disp	416.2	.368
2. Surgical Disp	404.5	.358
3. OB/GYN Disp	375.3	.332
4. Pediatric Disp	87.0	.077
5. Orthopedic Disp	1080.0	.956
6. Psychiatric Disp	825.2	.730
7. Medical OBD	108.7	.096
8. Surgical OBD	163.6	.148
9. OB/GYN OBD	132.0	.117
10. Pediatric OBD	143.7	.127
11. Orthopedic OBD	29.1	.026
12. Psychiatric OBD	48.3	.043
13. Medical CV	21.21	.019
14. Surgical CV	27.96	.025
15. OB/GYN CV	19.62	.017
16. Pediatric CV	17.85	.016
17. Orthopedic CV	31.89	.028
18. Psych/MH CV	22.10	.020
19. Family Practice CV	27.43	.024
20. Primary Medical CV	19.31	.017
21. Emergency Medical CV	23.21	.021
22. Flight Medicine CV	31.44	.028
23. Undersea Medicine CV	5.55	.005
24. Dental Services WDP	7.08	.006
25. Dental Laboratories WDP	1.80	.002

Table 4. HCU Weights

DOD MEDICAL EXPENSE AND PERFORMANCE REPORT [1]	See Instructions in Chapter 5 of DOD 6010.10-M	RCS
NAME AND ADDRESS OF FACILITY (Include ZIP Code)	FACILITY CODE (UIC)	REPORT PERIOD
Hospital Nr. 4		FY79-1
REPORTING AUTHORITY	DOD MEDICAL REGION	

PART I - DIRECT PATIENT CARE (Direct Expenses Plus Support and Ancillary Services Assignments and Performance)

INPATIENT CARE	HCUs	DISPOSITIONS	TOTAL EXPENSES INCLUDING CLINICIAN SALARY	CLINICIAN SALARY EXPENSE	OCCUPIED BED DAYS
MEDICAL CARE	541.1	590	660,571	24,028	3,375
SURGICAL CARE	660.3	626	707,962	36,202	2,947
OBSTETRICAL/GYNECOLOGICAL CARE	549.7	721	637,746	20,019	2,652
PEDIATRIC CARE	393.9	675	400,344	4,590	2,692
ORTHOPEDIC CARE	211.0	180	232,448	14,045	1,533
PSYCHIATRIC CARE	151.0	117	134,810	2,865	1,526
TOTAL	2,507.9	2,909	2,773,881	101,749	14,725

AMBULATORY CARE	HCUs	TOTAL OUTPATIENT EXPENSES	OUTPATIENT VISITS	INPATIENT VISITS [2]
MEDICAL CARE	201.8	155,043	10,278	341
SURGICAL CARE	221.0	228,613	8,411	429
OBSTETRICA GYNECOLOGICAL CARE	273.5	196,453	16,087	0
PEDIATRIC CARE	265.2	215,726	16,573	0
ORTHOPEDIC CARE	397.6	156,313	14,030	169
PSYCHIATRIC/MENTAL HEALTH CARE	123.0	57,693	5,890	261
FAMILY PRACTICE CARE	285.0	274,073	11,877	0
PRIMARY MEDICAL CARE	1,357.8	1,447,811	79,873	0
EMERGENCY MEDICAL CARE	123.4	327,749	5,878	0
FLIGHT MEDICINE CARE	0.0	0	0	0
UNDERSEAS MEDICINE CARE	0.0	0	0	0
TOTAL	3,248.3	3,059,474	168,897	1,200

DENTAL CARE	HCUs	TOTAL EXPENSES	WEIGHTED DENTAL PROCEDURE	WEIGHTED DENTAL PROSTHETIC WORK UNIT
DENTAL SERVICES	50.5	89,172	8,422	NA
DENTAL LABORATORIES (Class 2 and 3 only)	2.2	3,436	NA	1,102
TOTAL	52.7	92,608	8,422	1,102

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[1] SEE ATTACHED CAVEATS
[2] EXPENSES INCLUDED IN INPATIENT CARE ACCOUNTS

TOTAL HCUs 5,808.9

Table 5. MEPR with HCUs

Chapter 7
CONCLUDING REMARKS

In this report we have formulated a new measure of output for the military hospital--the Health Care Unit. It is, essentially, a weighted sum of the performance factors reported for the 19 final accounts in the Uniform Chart of Accounts. We have illustrated a number of ways to define and compute the weights. Which way is "best" is to some degree a subjective matter; to be prudent, however, the way they are chosen should satisfy certain technical properties such as those discussed in Chapter 3 and should also inspire a high degree of confidence and acceptance by those who use these measures in decision-making.

It is worth noting once more that the HCU, like the CWU and AAE, is a measure of output and should not be thought of as a model which will compute directly the required budget and manpower necessary to operate the hospital. It is, of course, an extremely important input to the process of resource allocation, but other factors must be considered as well.

Inevitably, comparisons will (and indeed should) be made between the HCU and the CWU. The ultimate test, of course, is which measure is perceived to be most reponsive to the needs of the user in assessing hospital output. Even before the UCA data is available to run quantitative comparisons between the two, some judgments can still be made on the basis of the inherent characteristics of each measure. We feel that the HCU shows an advantage in the following areas:

- Case Mix. The inpatient and ambulatory care provided by the hospital is computed on the basis of 23 performance factors in 17 final accounts, compared with the CWU's use of but four performance factors. This finer degree of partitioning, with weights suitably chosen to reflect the intensity of care typically provided in each service represented as a final account, allows differences in case mix between hospitals to be seen more clearly. Should an even greater attention to care mix differences prove desirable, the HCU can easily be modified to use the UCA sub-account data giving more than a hundred categories of care.

- Dental Service. Two categories of dental care are used in determining the hospital output by means of the HCU. The CWU does not credit dental service toward hospital output.

- Output Units. The output is expressed in terms of equivalent admissions which we believe to be preferable to the dimensionless output of the CWU.

- UCA-Based. The UCA will be the accounting system used by all DOD hospitals for the foreseeable future. It seems appropriate to base hospital output directly upon information derived from the accounting system.

- Updating. A built-in mechanism is available for recomputing the weights whenever it seems desirable to do so. A study does not have to be initiated as would be the case for the CWU.

It was beyond the scope of this project to develop applications for the HCU; however, we feel that it has at least two major uses beyond reporting hospital output alone. First of all, it could be used as an input--perhaps the principal input--to a high quality resource allocation model, but this is the subject of a study all by itself.

Secondly, and perhaps a more direct extension, the HCU is an ideal basis for a management information system which could be useful at all organizational levels. The HCU can provide valuable information to the hospital commander on how the output of his hospital as a whole compares with that of other hospitals and also how the output of the various clinics within his hospital compare with each other. Since the performance factors used in computing the output are directly identified with the UCA final accounts which report the expense incurred, productivity comparison can be made as well. Such comparisons are not meaningful with the CWU since outpatient visits are all weighted the same as are admissions and also bed days. The following abbreviated example will illustrate this point.

Clinic	Visits	UCA Expense	Nr. Phys	Weight	HCU	CWU
Pediatric	3000	90,000	3	.016	48.0	900
Orthopedic	1800	110,000	2	.028	50.4	540

Here, even though there are fewer visits to the orthopedic clinic (hence fewer CWUs generated), because of the greater complexity of each visit (as reflected in the weights) more HCUs are generated. Productivity comparisons can be made as well as we see below:

Clinic	HCU/Phy	HCU/$
Pediatric	16.0	.00053
Orthopedic	25.2	.00046

Clearly other ratios such as HCU/Nurse, HCU/PA, HCU/Admin Person, etc., could be calculated as well. These values would appear to be useful indicators, but they obviously cannot stand alone. Rather they must be interpreted in the light of all the other factors which affect hospital productivity. Looking back to the example once more, it can be seen that the use of the raw UCA performance factors, or the CWUs which are derived directly from them, do not provide meaningful comparisons of either output or productivity since no differentiation in intensity of care is made between visits to the two different clinics.

While comparing the total output of two hospitals probably will not yield much useful information, comparing productivity can be interesting provided certain precautions are taken. The cases encountered in large teaching hospitals tend to be more complex than those in smaller non-teaching hospitals. Therefore, it would be unwise to compare the productivity of Bethesda with that of New London, for example. Some form of peer grouping is necessary. Currently, the terms primary, secondary and teriary care are used to group hospitals, but many other possibilities exist--number of beds, average length of stay, type of population served, case mix to name a few. Indeed, peer grouping hospitals as a whole may not be the best approach for some applications. As an example, if the surgery clinics were being examined, it might be appropriate to peer group by some characteristics of those particular clinics rather than by the hospital as a whole. There is considerable room for creative thinking in this entire

area. We believe that there exists a great potential for using the HCU, with appropriate peer grouping, as the basis for a total management information system for the DOD hospitals. Providing easily interpreted information in a timely manner to all levels within the organization could be a major step in improving total system productivity.

In conclusion we believe that the HCU, whether used only as a measure of hospital output or as a part of yet-to-be-developed resource allocation models and management information systems, represents a logical step forward in the quest for a meaningful indicator of hospital performance. While the HCU is ready to be implemented as soon as the FY80 UCA data is available to calculate the weights, the "fine tuning" and final validation can be accomplished only after several additional quarters (perhaps as many as eight) of UCA data from all the DOD hospitals are available. We feel confident that at that time the Health Care Unit will be the standard of output for military hospitals.

Appendix A
METHODS FOR UPDATING WEIGHTS

Introduction

When defining an output measure as a weighted sum, there is a definite need to keep the weights up-to-date so that they accurately reflect the current level of input required to produce a certain level of output. On the other hand, the weights must be reasonably stable so that the output measure is easily interpreted and is comparable over the years. This appendix discusses four specific possibilities for updating weights--continual update, base year, cumulative, and exponential smoothing. Once the UCA reporting procedures have stabilized and all hospitals are on line, we would expect the weights calculated from year to year to be relatively constant so that the short term impact of the different updating procedures is small.

Continual Update

This procedure specifies that new weights be calculated each period we calculate the product measure, and that the new weights be calculated using just the data for the current period. For example, if we use the median by hospital procedure (see page 15) for calculating weights for each quarter, we get the following weights for Account #16.

Quarter 4	FY78	17.23
Quarter 1	FY79	15.74
Quarter 2	FY79	15.42
Quarter 3	FY79	15.55

In each case, the data used to calculate the weight is strictly the data for the period to which the weight is applied. Weights probably should not be recalculated more than once per year to avoid seasonal fluctuations.

Base Year

The base year approach specifies that a weight is calculated at some point and is then used from that point forward. This

method keeps the weights constant over long period of time and the only way to update is to periodically change the base year.

Cumulative

This procedure requires the calculation of new weight for each period we calculate a product measure; however, in doing this calculation, we use all the data for a specified number of periods. For example, if we used the median by hospital procedures, and specified three quarters of data for the calculation, the FY79-2 weight for Account #16 would be based on FY78-4, FY79-1, and FY79-2 data. The resulting value would be 15.85. To do the FY79-3 calculation, the FY78-4 data would be dropped, and the FY79-3 data would be added. The result would be 15.63. As a general rule, as the number of periods of data used for each calculation increases, the influence of the current period data decreases, and the weight becomes more stable.

Exponential Smoothing

The weight calculated for each period using this method is a convex combination of the weight used in the previous period and the weight calculated using just current period data. Specifically, if W is the weight used last period, and w is the weight calculated on the current period, the new weight is given by

$$W^* = qw + (1-q)W$$

where $0 \leq q \leq 1$.

For example, consider the current weights calculated in the continual update example and let q = .2. If 17.23 is the weight used in FY78-4, then the weights for Quarter 1, 2, and 3 of FY79 would be given by:

Quarter 1: $W^* = (.2)(15.74) + (.8)(17.23) = 16.93$

Quarter 2: $W^* = (.2)(15.42) + (.8)(16.93) = 16.63$

Quarter 3: $W^* = (.2)(15.55) + (.8)(16.63) = 16.41$

Notice that in the limit, if q = 1, we have the continual update case, and if q = 0, we have the base year case.

Appendix B
COMPUTATION OF INPATIENT WEIGHTS

Introduction

Two performance factors are reported for each of the six inpatient accounts in the UCA, dispositions and occupied bed days. Since these two measures "overlap," we must develop a weighting scheme which combines them in a meaningful way. This appendix examines in some detail three different approach to this problem--each of which uses regression analysis.

Direct Regression

The direct regression method uses a standard "least squares" methodology to estimate the W_D and W_B in the model below:

$$\text{Cost}_i = W_D(\text{dispositions})_i + W_B(\text{bed days})_i + (\text{Error})_i$$

The weights estimated in this manner are then used to calculate the product measure for all hospitals.

For example, in Account #3, FY79-1, the data are as follows:

Hospital	Total Cost	Dispositions	Bed Days
1	163,369	196	683
2	717,972	883	3,226
3	251,351	158	1,323
4	637,746	721	2,652
5	218,162	237	825
6	233,540	268	894
7	263,527	286	1,254
8	236,645	220	871
9	600,374	598	3,405
	3,322,686	3,567	15,133

Table B-1. Inpatient OB-GYN Data, FY79-1

Using the direct regression approach, the following weights were obtained:

$$W_D = 485.32$$
$$W_B = 99.20$$

Thus the product measure is determined by the formula

485.32 (dispositions) + 99.20(bed days)

and the results for the nine hospitals are reported below.

Hospital	Total Cost	Product Measure
1	163,369	162,876
2	717,972	748,557
3	251,351	207,922
4	637,746	612,994
5	218,162	196,861
6	233,540	218,751
7	263,527	263,198
8	236,645	193,174
9	600,374	627,997

Table B-2. OB-GYN Output Calculations-Direct Regression

These results were reasonably appealing since one could interpret the number 485.32 as a measure of the overhead intensity of care associated with each case, and the 99.20 as a measure of the intensity of care associated with each bed day in the ward. However, when this system was applied to Account #6, Orthopedic Care, the derived weights were 1594.20 and -40.23 for dispositions and bed days respectively. Even though the regression analysis has indicated that this choice of weights explains the variation in cost better than any other, their use in a product measure seems undesirable since increasing an individual patient's stay would actually reduce the credit received for his care.

As we proceeded through the test data using the direct regression approach, we found that negative weights appeared often. It is possible that this phenomena is solely a result of the small number of hospitals for which data were available, and would therefore be entirely acceptable when the UCA data from all the DOD hospitals are available.

Indirect Regression

This approach is based on the premise that since the weights for dispositions and the weights for bed days are each chosen

in a way to explain variations in cost, then surely there is a convex linear combination of these factors which will be at least as highly correlated with cost as either of them individually. Following is the procedure for making these calculations.

1. Calculate weights for both dispositions (W_D) and bed days (W_B) using any one of the methods outlined on page 15 of the report.

2. Compute two product measures for each hospital--P_{1i} using W_D times the number of dispositions, and P_{2i} using W_B times the number of bed days.

3. Define a new product measure, P_i, as a convex combination of P_{1i} and P_{2i}. That is, let $P_i = KP_{1i} + (1-K)P_{2i}$ where K is a number between zero and one.

4. Find the value of K which maximizes the correlation between P_i and cost.

5. Calculate the new weights W_D^* and W_B^* as follows:

$$W_D^* = KW_D$$

$$W_B^* = (1-K)W_B$$

Since we restrict K to values between zero and one, the values of W_D^* and W_D^* must be non-negative and the problem of negative weights found with direct regression is eliminated. Another advantage of this procedure is that the starting point can be any of the four weighting schemes presented on page 15. The direct regression procedure lacks this flexibility.

For example, again consider the data in Table B-1. The overall average method gives initial weights of $W_D = 3322686/3567 = 931.51$ and $W_B = 3322686/15133 = 219.57$. Applying these weights to the data to get P_{1i} and P_{2i} gives the information contained in Table B-3. In this case, the optimal K value is .58. That is, the new product measure $P_i = .58\ P_{1i} + .42\ P_{2i}$ correlates with cost better than any other convex combination of the P_{1i} and P_{2i}. This K value then gives final weights of

$$W_D^* = (.58)(931.51) = 540.28$$

$$W_B^* = (.42)(219.57) = 92.22$$

Hospital	Cost	P_{1i}	P_{2i}
1	163,369	182,576	149,966
2	717,972	822,523	708,333
3	251,351	147,179	290,491
4	637,746	671,619	582,300
5	218,162	220,768	181,145
6	233,540	249,645	196,296
7	263,527	266,412	275,341
8	236,645	204,932	191,245
9	600,374	557,043	747,636

Table B-3. OB-GYN Output Calculations--
Disposition and Bed Day

Finally, the formula for the product measure of each account is:

540.28(dispositions) + 92.22(bed days)

This relationship yields the following outputs for the nine hospitals.

Hospital	Total Cost	Product Measure
1	163,369	168,881
2	717,972	774,569
3	251,351	207,371
4	637,746	634,109
5	218,162	204,128
6	233,540	227,240
7	263,527	270,164
8	236,645	199,185
9	600,374	637,097

Table B-4. OB-GYN Output Calculations--
Indirect Regression

Calculation of weights using this indirect method often gives non-zero W_D and W_B weights similar to the example; however, there were also cases in which the K value was either zero or one indicating that using just dispositions or just bed days provides the best correlation.

Length of Stay Regression

This method exploits the relationship between cost per disposition and average length of stay in determining the weights which

should be assigned to dispositions and bed days in inpatient care accounts. Continuing with the concept of using cost to determine the weights leads one to examine the equation:

$$\text{Ave Cost/Disposition} = B_0 + B_1 \times (\text{Ave Length of Stay})$$

where the B_0 term represents a fixed expense associated with each disposition and the B_1 term represents the incremental cost associated with each additional day of care. The values of B_0 and B_1 are estimated by using standard linear regression. Multiplying both sides of the above equation by dispositions yields:

$$\text{Ave Cost} = B_0 \times (\text{dispositions}) + B_1 \times (\text{bed days})$$

so B_0 is indeed the weight for dispositions and B_1 that for bed days.

To illustrate this method, we have performed such a regression for each of the six inpatient accounts using the UCA test data. Each one was done using 27 points--three quarters of data for each of the nine hospitals. All points with a deviation of the dependent variable exceeding two standard deviations were considered to be outliers and had no part in determining the regression line. The plots of these points and the resulting lines are contained in Figures B1-B6, and the weights which were determined are listed in Table B-5.

Inpatient Account	Disposition Weights	Occupied Bed Day Weights
1. Medical	416.2	108.7
2. Surgical	404.5	163.6
3. OB/GYN	375.3	132.0
4. Pediatric	87.0	143.7
5. Orthopedic	1080.0	29.1
6. Psychiatric	825.2	48.3

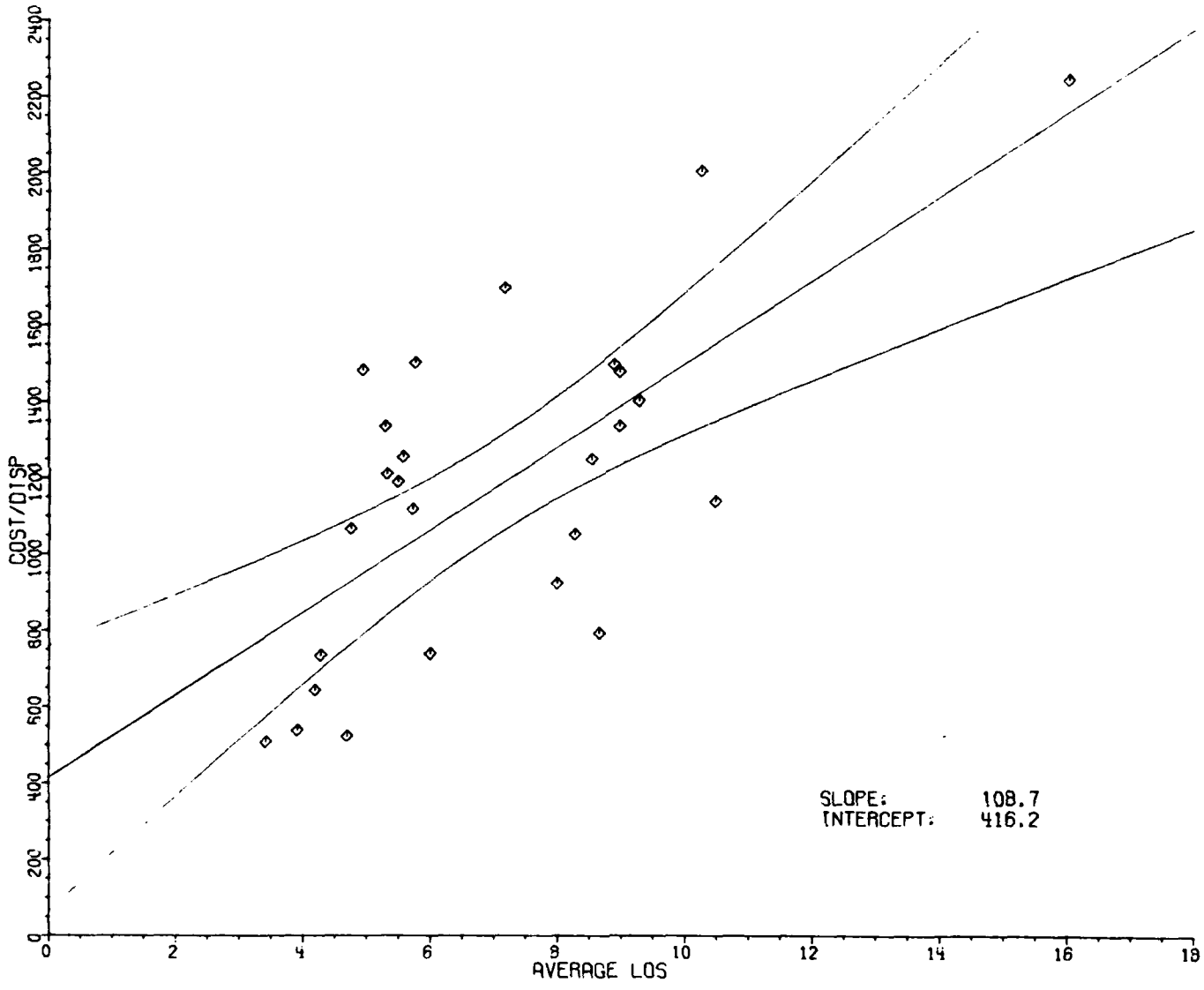
Table B-5. Inpatient Weights

Applying the weights from Table B-5 to the data in Table B-1 gives the OB/GYN output measures in Table B-6.

Hospital	Total Cost	Product Measure
1	163,369	163,715
2	717,972	757,222
3	251,351	233,933
4	637,746	620,655
5	218,162	197,846
6	233,540	218,588
7	263,527	272,864
8	236,645	197,538
9	600,374	673,888

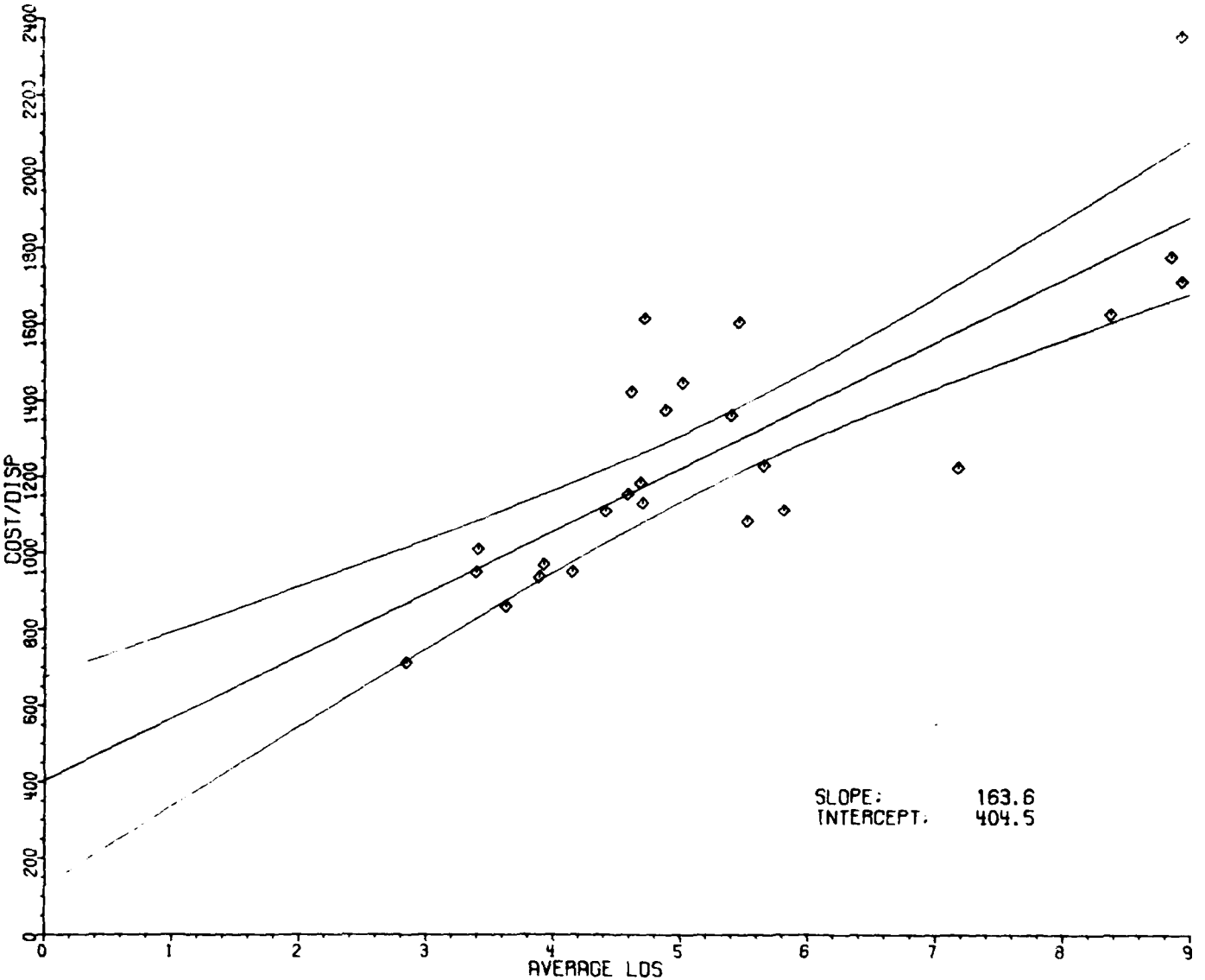
Table B-6. OB-GYN Output Calculations-LOS Regression

Calculating weights using this LOS regression method appears to give consistently reasonable results. Of the three methods presented, this method shows the most promise by far, although there is still a need to further refine the criteria for eliminating outliers once the UCA data from all of the military hospitals becomes available.



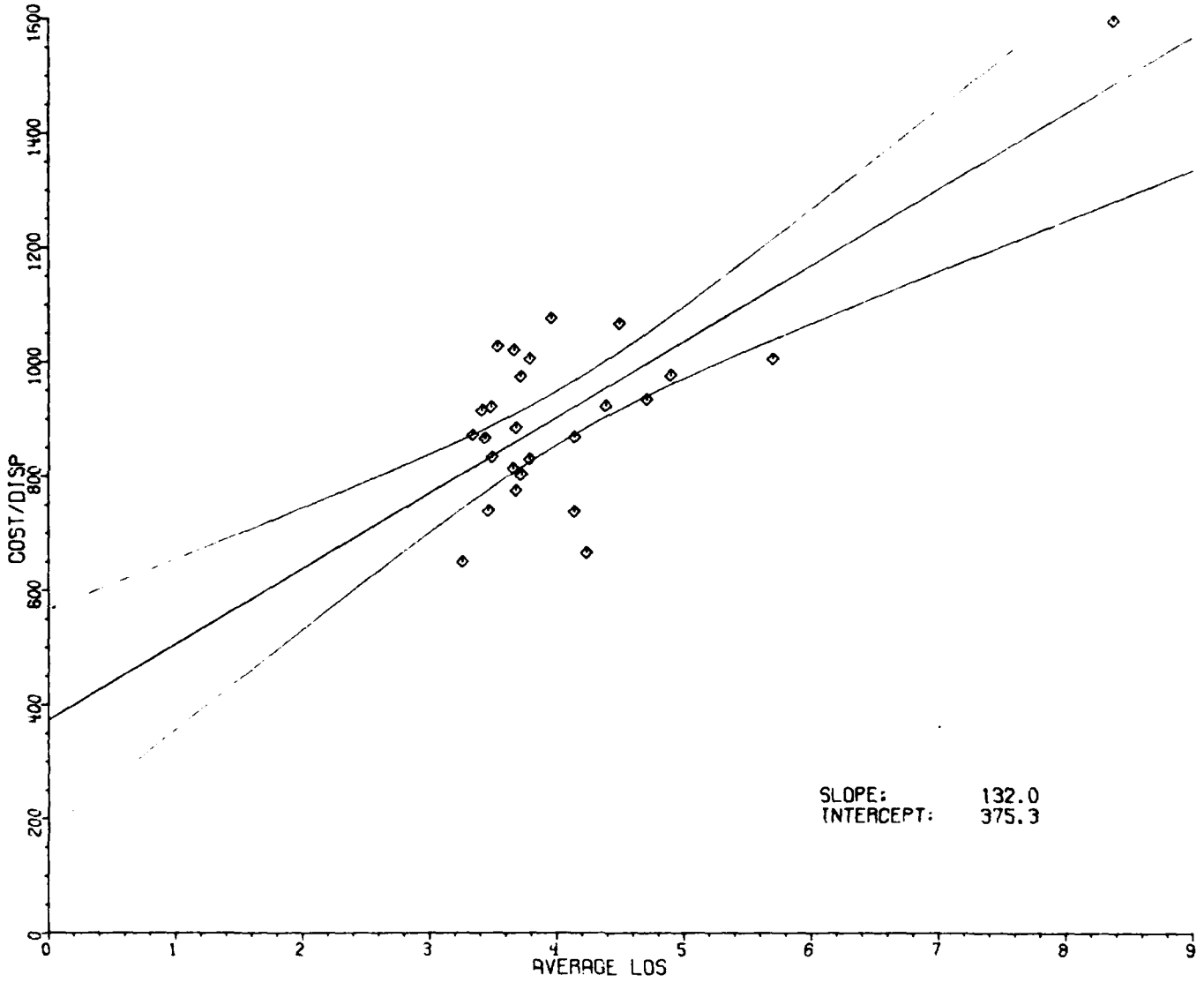
AVERAGE COST/DISP VS AVERAGE LOS FOR MEDICAL CARE(MINUS OUTLIERS)

Table B-1



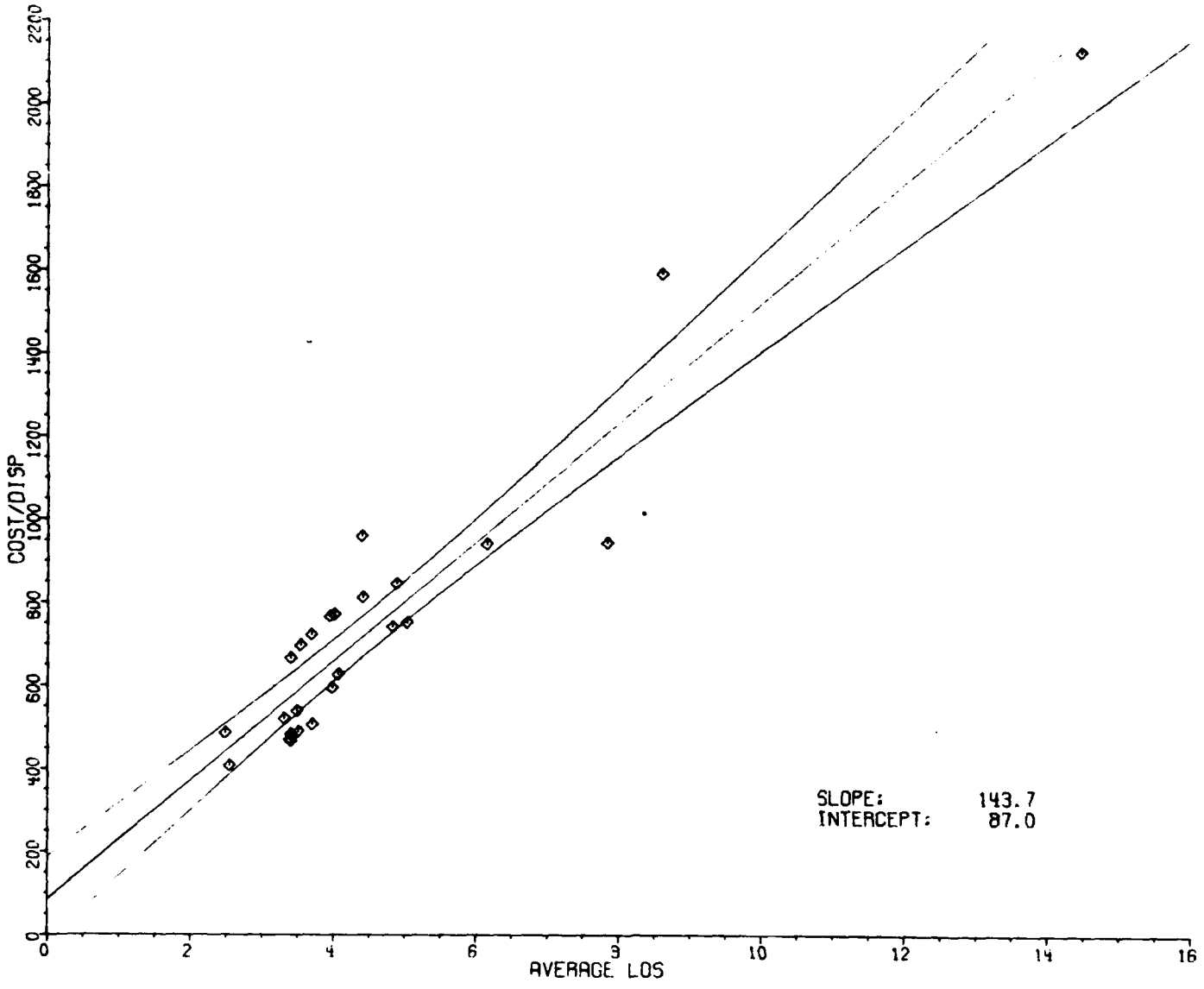
AVERAGE COST/DISP VS AVERAGE LOS FOR SURGICAL CARE(MINUS OUTLIERS)

Table B-2



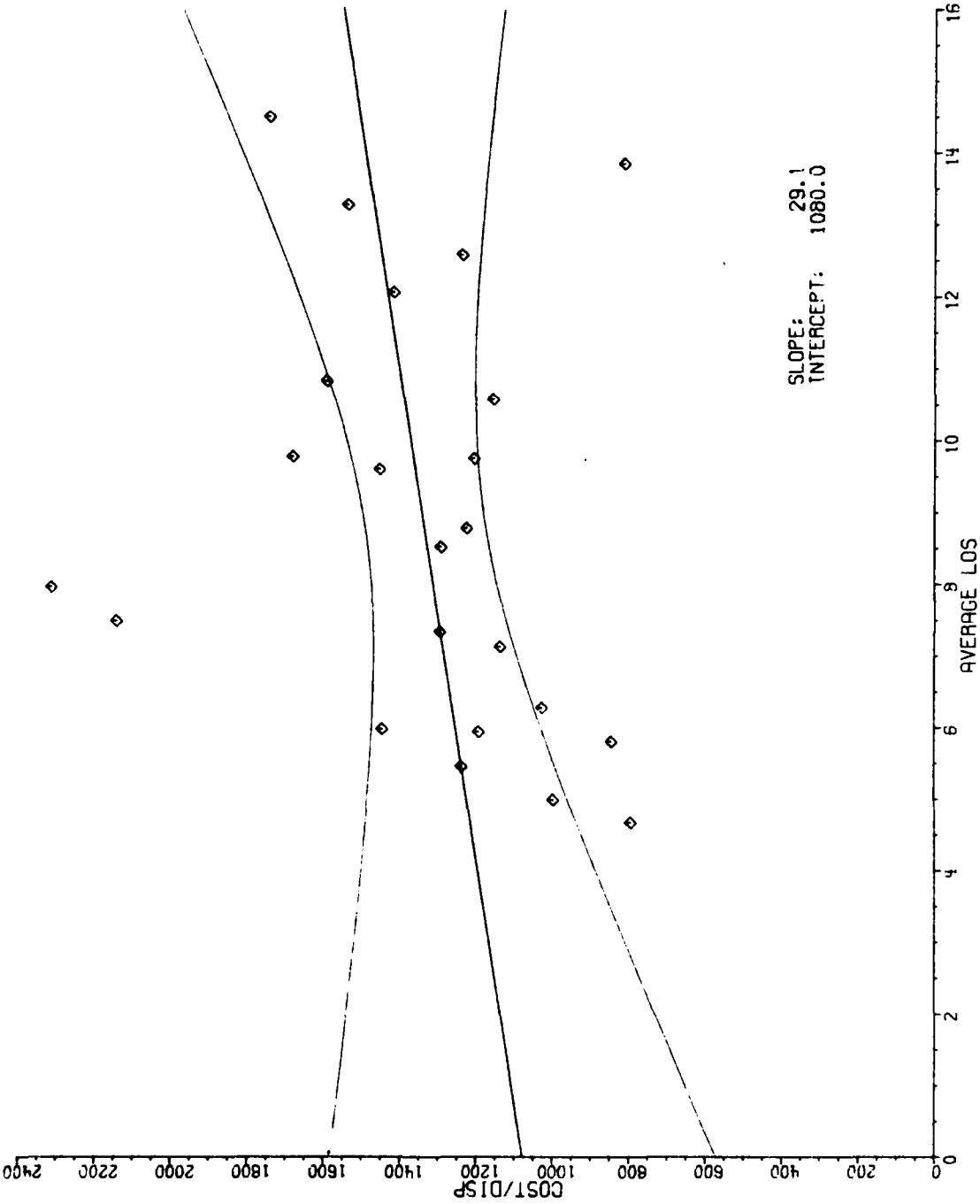
AVERAGE COST/DISP VS AVERAGE LOS FOR OB/GYN(MINUS OUTLIERS)

Table B-3



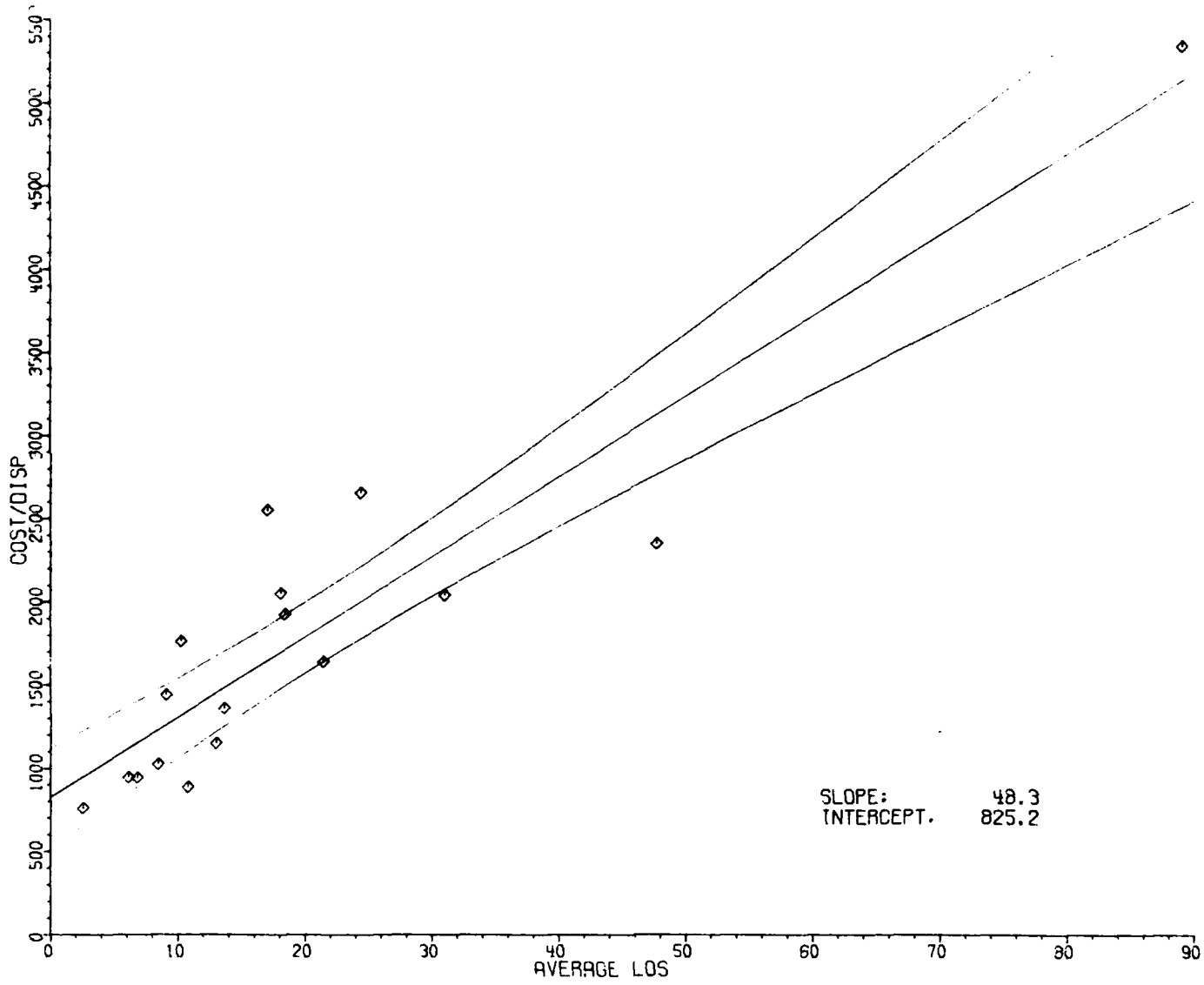
AVERAGE COST/DISP VS AVERAGE LOS FOR PEDIATRICS(MINUS OUTLIERS)

Table B-4



AVERAGE COST/DISP VS AVERAGE LOS FOR ORTHOPEDIC CARE(MINUS OUTLIERS)

Table B-5



AVERAGE COST/DISP VS AVERAGE LOS FOR PSYCHIATRIC CARE(MINUS OUTLIERS)

Table B-6

Appendix C

ORGANIZATIONS AND PLACES VISITED

Washington DC	Office of the Assistant Secretary of Defense, Health Affairs Surgeon General, US Army Surgeon General, US Navy Surgeon General, US Air Force Office of Management and Budget Veterans Administration
Chandler, AZ	Williams AFB Hospital
Tempe, AZ	Dept of Industrial Engineering Arizona State University
Fort Huachuca, AZ	Raymond W. Bliss Army Hospital
San Antonio, TX	US Army Health Services Command
Camp Pendleton, CA	US Naval Hospital
Oakland, CA	US Naval Hospital
Monterey, CA	Naval Postgraduate School Defense Manpower Data Center
New Haven, CT	Yale University
Milwaukee, WI	ORSA/TIMS Meeting
Aurora, CO	Office of CHAMPUS
Santa Monica, CA	The RAND Corporation
USAF Academy, CO	USAF Academy Hospital
Orlando, FL	AIIE/HMSS Conference

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