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THE ORKAND CORPORATION

SILVER SPRING, MARYLAND

MARGINAL COST STUDY OF SELECTED CONUS ARMY MEDICAL TREATMENT FACILITIES
FINAL REPORT

June 1, 1979

Prepared for:

Colonel Donald M. Graydon
Directorate of Resources Management
Office of The Surgeon General
Department of the Army
Washington, D.C. 20301

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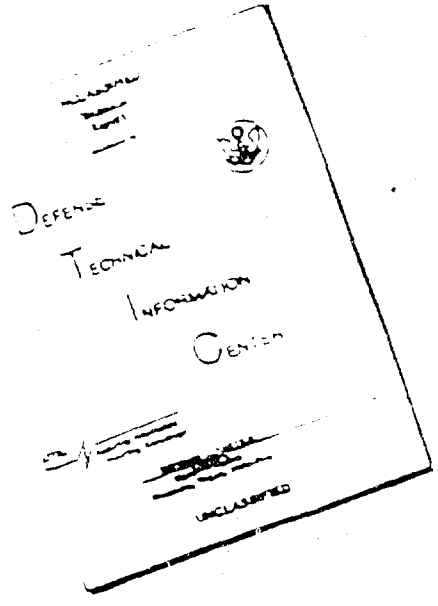

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This two-pronged study resulted in a methodology for determining marginal inpatient, clinic visit, and delivery costs, and the production of facility reports and specific marginal costs for eight medical treatment facilities. The methodology algorithmically describes data collection and manipulation procedures, and permits the calculation of marginal costs for 39 separate patient classes. Each patient class consists of a type of beneficiary (Active Duty, dependents of Active Duty, retirees, and dependents of retirees), the relevant

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hospital department (medical, surgical, obstetrics, gynecology, pediatrics, and all other), and an appropriate service measure (patient stay, ambulatory clinic visit, and for obstetrical patients, delivery, which includes the other two measures). Individual facility reports compared marginal costs with the corresponding local CHAMPUS costs for the above patient types.

Comparisons of facility-specific marginal costs with corresponding total (patient and government) CHAMPUS costs show in summary: For inpatient classes, 90.6 percent of the marginal costs were less than half of the CHAMPUS costs; for outpatient classes, 98.9 percent of the marginal costs were less than half of the CHAMPUS costs; all marginal obstetrics costs were less than half of the CHAMPUS costs. Overall conclusion of the study, as expressed in the contractor's Final Report, was that "at the margin, it is significantly less expensive to provide treatment in an Army facility rather than a civilian medical treatment facility."

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MARGINAL COST STUDY OF SELECTED CONUS ARMY MEDICAL TREATMENT FACILITIES

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Final rept. Dec 76-Jun 79,

MDA903-77-C-0021

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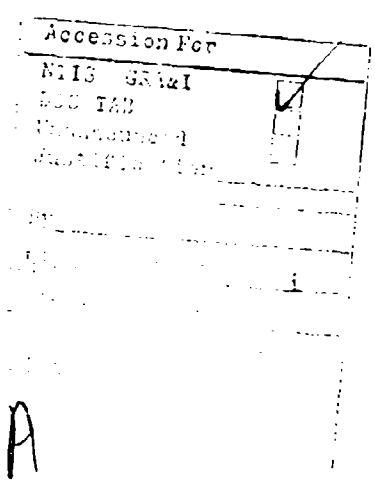

LIST OF EXHIBITS

I. INTRODUCTION

PURPOSE

This is the final report under Contract No. MDA 903-77-C-0021 a "Marginal Cost Study of Selected CONUS Army Medical Treatment Facilities." It specifies the objectives of the project, methods employed, data utilized, results and conclusions, and comments regarding the generalizability of the methodology to Army Medical Centers.

BACKGROUND AND OBJECTIVES

Purpose

The purpose of this study was to establish an operationally effective methodology for implementation of the economic concept of "marginal cost analysis" at Army medical treatment facilities and to conduct analyses of selected facilities using that methodology.

Background

The allocation of health care resources is of continuing concern to the Army, to the Office of the Secretary of Defense (OSD), to the Office of Management and Budget (OMB), and to the Congress. One effect of the recently completed OMB/HEW/DOD Military Health Care Study is a requirement to develop a procedure for determining facility level marginal costs of health care services delivered in military treatment facilities. The Defense Planning and Programming Guidance Memorandum for FY 78-82 further requires the Army to use marginal cost analysis in comparing alternative modes of health care delivery for some categories of installations. A recent Assistant Secretary of Defense (Health Affairs) Issue Paper ("Should DOD contract for health care in CONUS where such an alternative appears to be more efficient?") may place an additional requirement on the Army to identify medical treatment facilities whose marginal costs of operation equal or exceed the prices of alternative civilian sources of care.

Problem

While the Army is being required to use marginal cost concepts as a basis for policy decisions and medical resource allocations, only average costs are generated by present accounting and workload reporting systems. The study addressed the problem of employing currently available, functionally oriented, accounting and patient care data to develop marginal costs of specific health care outputs. One example of the stated problem is the use of existing manpower authorization and utilization reports, costs by elements of expense, and other hospitalization manpower and expense data to develop disaggregated costs for Medical, Surgical, OB/GYN, and Neuropsychiatric types of in-patient care.

System wide concepts are not applicable to individual Army medical treatment facilities, nor to many types of analyses and decisions the Army is required to undertake. Contractor support was required to develop an operationally useful mechanism for determining the marginal costs of direct patient care at the facility level.

Summary

The Contractor developed an operationally effective marginal cost methodology for Army medical treatment facilities. The resultant methodology was so written and documented as to permit future application by other Contractors or government agencies. The Contractor conducted marginal cost studies at selected Army facilities, tested the sensitivity of those study results, compared those Army marginal costs to civilian prices, and assessed the potential for generalized marginal costing applications.

TASKS COMPLETED

During the study The Orkand Corporation completed a series of tasks including the following:

Task 1. Establish an operational definition of "marginal cost" within the context of military-health care economics

The Contractor established an operationally useful definition of "marginal cost" in concurrence with the HQDA, OTSG Study Advisory Group.

Task 2. Develop a marginal cost methodology.

Using the definition of marginal cost established by Task 1, a methodology for determining the marginal costs of patient care applicable to individual Army general hospitals and clinics within CONUS was developed. The methodology was to:

a. Be fully documented, providing a step by step procedure which would permit future application by other Contractors or government agencies;

b. Utilize data generated by existing DA accounting, workload, and manpower reporting systems and any methodology requiring data not currently available will be considered less than optimal.

c. Be so designed as to produce, as a minimum, marginal costs in terms of costs per admission, per bed day of hospitalization, per clinic visit, and per live birth for the four categories of beneficiaries (Active duty, Dependents of Active Duty, Retirees, and Dependents of Retired and Deceased) at specified, individual, Army treatment facilities. Such results shall be further disaggregated, and classified into costs for Medical care, Surgical care, OB/GYN care, and Neuropsychiatric are (as appropriate) for each category of beneficiary;

d. Be consistent with the current Army health care mission and organization. The Army health care system has two basic functions. First, it provides health and medical care to Active Duty forces and serves as the nucleus of a mobilization base to provide Army forces with medical care in the event of conflict. Secondly, in peacetime, it provides routine health care for active duty, their dependents and other authorized personnel;

e. Reflect accepted general accounting practices and reflect accepted economic theories.

Task 3. Produce marginal cost data for selected Army medical treatment facilities.

Marginal cost data was generated for the following Army medical treatment facilities:

DeWitt Army Hospital, Fort Belvoir, VA
McDonald Army Hospital, Ft Eustis, VA
Kenner Army Hospital, Ft Lee, VA
Cutler Army Hospital, Ft Devens, MA
US Army Hospital, Ft Carson, CO
Hays Army Hospital, Ft Ord, CA
Letterman Army Medical Center, San Francisco, CA
Darnell Army Hospital, Fort Hood, Texas

Task 4. Conduct Sensitivity Studies of Marginal Cost Analyses.

The Contractor investigated the sensitivity of results obtained in Task 3 to changes in workload and other parameters at each location. The Army needed

to know the workload ranges for which specific marginal costs can be expected to remain valid and those points in the workload spectrum at which marginal costs begin to change significantly.

Task 5. Conduct Cost Comparisons between Army and civilian facilities.

The Contractor conducted comparisons between the marginal operating costs of the specified Army treatment facilities and the prices of like civilian care within the appropriate catchment areas.

Task 6. Assess potential for generalized marginal costing applications.

The Contractor investigated the extent to which the marginal cost model may be generalized for application to Army Medical Centers (MEDCENs) by including at the request of the OTSG, Letterman Army Medical Center (LAMC) in the specific hospitals for which marginal costs were to be calculated.

Specific findings and recommendations are included herein and in the LAMC facility report.

REPORT ORGANIZATION

Chapter II provides an overview of the Marginal Cost methodology. Chapter III contains a discussion of related issues to the methodology. Chapter IV contains the conclusions and recommendations.

II. OVERVIEW OF MARGINAL COST MEASUREMENT METHODOLOGY

OPERATIONAL DEFINITION OF MARGINAL COST

Economists generally define marginal cost as the increment of total cost that comes from producing an increment of one additional unit of some good or service; that is, the term, marginal, means "extra". In the short run where some proportion of total costs are fixed, marginal cost curves are U-shaped--at first falling due to increasing returns to scale, later rising as returns to fixed factors of production begin to decline. This concept is used by economists to explain rising short run supply curves of a firm or industry, production equilibrium, and maximum profit equilibrium.

Before a theory of marginal cost can be effectively utilized for the purpose of estimating marginal cost in selected Army hospitals, the concept requires considerable operationalizing with respect to:

- Particular Army hospital environment; e.g., period of marginal cost (MC) estimates, constraints, the nature of the decision and decision levels.
- How outputs are defined and counted.
- Conversion from an extra unit of hospital output to total costs "associated" with the additional output.

For purposes of this study, an operational definition of marginal cost is offered as follows:

> "Marginal cost is operationally defined as the change in total cost of resources required by a military hospital, in excess of defined resource levels, in order to expand (or contract) services to non-active duty patients."

This definition applies to a hospital's short-run supply curve; i.e., certain costs are fixed. The time frame relevant to this analysis of MC estimates extends no longer than five years.

The above definition has within it several significant practical concepts that render it operational for the Army's analytical purposes. First, differences in total cost are defined in terms of increments (or decrements) to hospital service levels; not simply one more or less unit of service. Here the economist's strict definition is somewhat modified since the Army's decision will never be framed in terms of one more or one less unit of service. Rather, the policy issue will normally center upon greater fluctuations in hospital service levels.

The change in total cost depends upon what costs are "associated" with changes in service levels. The units of change in service levels have been defined elsewhere. The enumeration of costs associated with changes in units of service depends upon the definition of "defined resource levels."

The operational definition of marginal cost requires adaptation to the types of decision models faced by Army hospitals as they consider increasing hospital services to non-active duty personnel who would otherwise use the CHAMPUS reimbursement mechanism. There are three basic decision models, each of which require different operational specifications of marginal cost. All decision models have a 0-5 year time frame. The major distinction between the three decision models is at what resource level are resource costs considered fixed by policy decision. The three models are:

- What are the marginal costs of expanding hospital service levels beyond that which can be sustained using resource levels fixed by active duty workload requirements?

- What are the marginal costs of expanding hospital service levels beyond that which can be sustained by current resource levels of that hospital?

- What are the marginal costs of expanding hospital service levels beyond that which can be sustained by contingency level resource requirements assigned to the hospital?

The first decision model recognizes that resources required to serve active duty personnel are fixed by statute. If current hospital service levels do not exhaust these fixed resources, the marginal cost of increased demand upon these resources is minimal since most of the resources represent no costs. It is only when resource requirements exceed those which are considered fixed that marginal costs are considered significant. The other two decision models postulate other definitions of fixed cost. The operational definition of marginal cost then depends upon what costs are considered fixed: i.e., the three decision models. The estimation of marginal cost for

any particular Army hospital then depends upon the decision model in question, current resources assigned to the hospital, and current patient loads.

The definition of marginal cost includes the cost of additional capital equipment and borrowed resources. It excludes any allocation of base support costs so long as such costs do not change as a result of changes in hospital service levels. The cost of capital goods will be defined as a straight-line depreciation over a maximum of eight years. All capital goods costing over $1,000 will be depreciated using this formula. Borrowed resources will be costed if not already charged to a hospital budget.

The above operational definition of marginal cost is clearly not simply a budget concept. Resource requirements to provide hospital service levels beyond the capability of defined resource limitations must be costed in a comprehensive manner. Some of the costs will have a financial or budgetary impact upon a hospital, such as acquisition of new capital goods and manpower, while other short-run resource acquisitions may not; e.g., borrowed labor or the use of labor that does not get charged to the hospital budget. Our operational definition of marginal cost employs the economist's perspective that all variable resources have "opportunity costs"; i.e., their value is the next best use. Therefore, the cost of all resources associated with hospital service levels beyond defined resouce constraints are considered marginal. Costs that would not appear directly in the hospital's budget will be allocated to marginal cost estimates by estimating the value or cost of the resource over the time within which it is used.

PATIENT CLASSIFICATION

Since the Army Medical Department provides a wide variety of health services to at least four discrete beneficiary categories, those services and beneficiaries have been organized into a three dimensional matrix. Exhibit II-1 illustrates this matrix which subsumes all possible services provided to all beneficiary categories in mutually exclusive cells. The first dimension of the matrix is the beneficiary categories: active duty personnel, dependents of active duty personnel, retired personnel, and dependents of retired personnel and survivors. The second dimension is the division of health care into six service categories: medical, surgical, obstetrics, gynecology, pediatrics, and all other services. The third dimension delineates three measures of services provided eligible beneficiaries: patient stay, ambulatory clinic visit and delivery. These are defined as follows:

- Patient Stay - An episode of inpatient health care, excluding obstetrical episodes, which occurs between the time a patient is admitted to a military hospital until discharge or other disposition.

Exhibit II-1

Classification Matrix

Service Categories/ Measures \ Beneficiary Category		Active Duty	Dependents	Retirees	Dependents of Retirees & Survivors
Medical	Patient Stay				
	Ambulatory Clinic Visits				
Surgical	Patient Stay				
	Ambulatory Clinic Visits				
Obstetrics	Deliveries			a/	
Gynecology	Patient Stay				
	Ambulatory Clinic Visits				
Pediatrics	Patient Stay	a/		a/	
	Ambulatory Clinic Visits	a/		a/	
Other	Patient Stay				
	Ambulatory Clinic Visits				

a/ Probable null or very small sets.

- Ambulatory Clinic Visit - A nonobstetrical clinic visit not associated with inpatient health care status.

- Delivery - The total episode of health care associated with obstetrical services, to include inpatient and outpatient care.

The division of Army Medical Department health care delivery into this matrix accomplishes two objectives. It first accounts, in part, for the heterogeneity of health services. Since different mixes of resources are required to provide different services and since different population groups require different services, these patterns have been incorporated into the design of the matrix. Secondly, the matrix is decision oriented. The Army Medical Department is obligated without qualification to provide health care in the direct care system to the active duty beneficiary category. Each of the other categories is provided direct care as resources are available and on a priority basis among the three: or in the civilian community through CHAMPUS. The availability of resources in the direct care system and the demands for those resources among the beneficiary categories may be more effectively ascertained in the matrix format so as to form the basis of decisions to increase or decrease care provided to any or all of the other than active duty beneficiaries.

PRODUCTION FUNCTIONS

Based on the operational definition of marginal cost, it is necessary to determine the change in the total cost of resources associated with serving additional patients. To that end, a production function approach was taken. This approach assumes that there is a definite and measurable relationship between resources and patients. That is, one can model and measure the amount of resources required to serve each patient. In marginal costing, this approach means that if the amount of resources required by additional patients is greater than the existing amount, additional resources must be acquired. The costs of these additional resources, being a function of the additional patients, are therefore the marginal cost of adding the new patients.

In operation, this approach is complicated by two factors. One is that any patient receiving care in an Army hospital places a unique demand on resources. In no way can that demand be accurately measured until that patient presents himself for treatment. However, it is possible to ascertain an average patient demand for hospital resources. But the variability around this average may be so great as to render the average useless as a tool for measuring the resource/patient relationship. Hence the classification matrix groups patients into similar but sufficiently large classes. It is assumed that each patient demands a mix of resources similar to all other patients in

its group such that the variability around the average demand in a class is less than the variability around the average demand if all patients were grouped as a whole. This classification scheme further assumes that the average demand for resources in one class is different from the average demand in all other classes.

The production function approach is further complicated by the fact that differentiated resources are grouped into organizational sub-units (i.e., departments) of a hospital. Hospital resources do not provide direct services to patients which may be measured but rather indirect services which are defined as departmental products. In other words, resources combine in departments to produce an output (i.e., products) and these departmental products are demanded by individual patients.

The production function approach to marginal costing as used in this methodology is predicated on developing the following relationships:

- Between departmental products and patients
- Between resources and departmental products
- Between costs and resources.

For the purposes of this manual, the following direct care hospital departments and their products will be considered:

- Medical Hospitalization (Bed days)
- Surgical Hospitalization - subdivided into:
  - Surgical Hospitalization I (Bed Days) - nursing wards
  - Surgical Hospitalization II (Episodes of surgery) - operating room, recovery room, anesthesiologists, and anesthesia nursing
- OB/GYN Hospitalization (Bed days)
- Pediatrics Hospitalization (Bed days)
- Other Hospitalization (Bed days)
- Medical Clinics (Clinic visits) - further subdivided into the individual clinics composing this department such as internal medicine, general outpatient, etc.

- Surgical Clinics (Clinic visits) - also subdivided into individual clinics
- OB/GYN Clinics (Clinic visits)
- Pediatrics Clinics (Clinic visits)
- Other Clinics (Clinic visits) - also subdivided into individual clirics

Additionally, the following ancillary departments will be considered:

- Radiology (Films exposed)
- Pathology (CAP weighted laboratory procedure unit values)
- Pharmacy (Prescriptions)
- Food Service (Meals served)

Finally the following indirect departments will be considered:

- Administration (various) - subdivided into individual sections
- Medical Material (Requisitions)
- Medical Maintenance (Jobs completed)
- Linen Service (Pieces of linen)
- Ambulance Service (Runs)

Each of these departments employ the following resource types to produce departmental products:

- Personnel - Identified by the following three categories:
  - Officers with Medical Specialties
  - Other Officers
  - Enlisted Personnel
- Materiel - Defined in terms of a "standard unit" of one; since materiel consists of a very large number of items but is very small (both absolutely and relatively) in comparison to other inputs, it is

not cost-effective to specifically enumerate use of materiels by item or unit. Hence an "average cost" related standard unit (always defined as one) will be applied to each input function.

- Equipment - Defined in terms of each machine and/or piece of equipment.

Exhibits II-2 through II-6 illustrate the relationships between resources and departmental products, and between departmental products and patient categories.

Finally, the marginal cost of health care delivered in an Army hospital becomes the cost of acquiring additional resources associated with additional patients served. The production function approach is therefore used to describe the following causal relationships:

- Increased patients served leads to increased production of departmental products (at the rate specified in the coefficients (a, b, k in Exhibits II-2 through II-5) corresponding to individual patient types and departments

- Increased production of departmental products leads to increased demand for resources at the rate specified in the coefficients (g, h, i in Exhibits II-2 through II-5) corresponding to departmental products and resource types.

- Increased demand for resources, leads to the need for additional resources if the capacity of existing resources is insufficient to meet the demand

- The need for additional resources leads to the incurrance of a cost to acquire those resources.

And these costs are marginal when applied to the additional patients which caused them.

MARGINAL COST MODEL

To operationalize the production function approach and to determine the marginal costs of health care in a military treatment facility, then, a model has been designed which incorporates three information requirements: the specified relationships between departmental products and patient types, the resources required to produce departmental products to include the levels at which resources must be acquired to increase product outputs, and the costs of

Exhibit II-2

Active Duty Beneficiary Production Functions[1]

Output Categories		Functions
Service	Measure	
Medical	Patient Stay	$aX_1 + bX_2 + \ldots kX_n$ / $gY_n + hZ + iQ$
	Ambulatory Clinic Visits	$aX_1 + bX_2 + \ldots kX_n$ / $gY_n + hZ + iQ$
Surgical	Patient Stay	$aX_1 + bX_2 + \ldots kX_n$ / $gY_n + hZ + iQ$
	Ambulatory Clinic Visits	$aX_1 + bX_2 + \ldots kX_n$ / $gY_n + hZ + iQ$
Gynecology	Patient Stay	$aX_1 + bX_2 + \ldots kX_n$ / $gY_n + hZ + iQ$
	Ambulatory Clinic Visits	$aX_1 + bX_2 + \ldots kX_n$ / $gY_n + hZ + iQ$
Other	Patient Stay	$aX_1 + bX_2 + \ldots kX_n$ / $gY_n + hZ + iQ$
	Ambulatory Clinic Visits	$aX_1 + bX_2 + \ldots kX_n$ / $gY_n + hZ + iQ$
Obstetrics	Deliveries	$aX_1 + bX_2 + \ldots kX_n$ / $gY_n + hZ + iQ$

[1] See explanation of notation at Exhibit II-6

Exhibit II-3

Active Duty Dependents Beneficiary Production Functions[1]

Output Categories		Functions
Service	Measure	
Medical	Patient Stay	$aX_1 + bX_2 + \ldots kX_m$ ▲ ▲ ▲ ▲ ▲ $gY_n + hZ + iQ$
	Ambulatory Clinic Visits	$aX_1 + bX_2 + \ldots kX_m$ ▲ ▲ ▲ ▲ ▲ $gY_n + hZ + iQ$
Surgical	Patient Stay	$aX_1 + bX_2 + \ldots kX_m$ ▲ ▲ ▲ ▲ ▲ $gY_n + hZ + iQ$
	Ambulatory Clinic Visits	$aX_1 + bX_2 + \ldots kX_m$ ▲ ▲ ▲ ▲ ▲ $gY_n + hZ + iQ$
Gynecology	Patient Stay	$aX_1 + bX_2 + \ldots kX_m$ ▲ ▲ ▲ ▲ ▲ $gY_n + hZ + iQ$
	Ambulatory Clinic Visits	$aX_1 + bX_2 + \ldots kX_m$ ▲ ▲ ▲ ▲ ▲ $gY_n + hZ + iQ$
Pediatrics	Patient Stay	$aX_1 + bX_2 + \ldots kX_m$ ▲ ▲ ▲ ▲ ▲ $gY_n + hZ + iQ$
	Ambulatory Clinic Visits	$aX_1 + bX_2 + \ldots kX_m$ ▲ ▲ ▲ ▲ ▲ $gY_n + hZ + iQ$
Other	Patient Stay	$aX_1 + bX_2 + \ldots kX_m$ ▲ ▲ ▲ ▲ ▲ $gY_n + hZ + iQ$
	Ambulatory Clinic Visits	$aX_1 + bX_2 + \ldots kX_m$ ▲ ▲ ▲ ▲ ▲ $gY_n + hZ + iQ$
Obstetrics	Deliveries	$aX_1 + bX_2 + \ldots kX_m$ ▲ ▲ ▲ ▲ ▲ $gY_n + hZ + iQ$

[1] See explanation of notation at Exhibit II-6

Exhibit II-4

Retired Beneficiary Production Functions[1]

Output Categories		Functions
Service	Measure	
Medical	Patient Stay	$\frac{aX_1 + bX_2 + \ldots kX_m}{gY_n + hZ + iQ}$
	Ambulatory Clinic Visits	$\frac{aX_1 + bX_2 + \ldots kX_m}{gY_n + hZ + iQ}$
Surgical	Patient Stay	$\frac{aX_1 + bX_2 + \ldots kX_m}{gY_n + hZ + iQ}$
	Ambulatory Clinic Visits	$\frac{aX_1 + bX_2 + \ldots kX_m}{gY_n + hZ + iQ}$
Gynecology	Patient Stay	$\frac{aX_1 + bX_2 + \ldots kX_m}{gY_n + hZ + iQ}$
	Ambulatory Clinic Visits	$\frac{aX_1 + bX_2 + \ldots kX_m}{gY_n + hZ + iQ}$
Other	Patient Stay	$\frac{aX_1 + bX_2 + \ldots kX_m}{gY_n + hZ + iQ}$
	Ambulatory Clinic Visits	$\frac{aX_1 + bX_2 + \ldots kX_m}{gY_n + hZ + iQ}$

[1] See explanation of notation at Exhibit II-6

Exhibit II-5

Dependents of Retirees and Survivors Beneficiary Production Functions[1]

Output Categories		Functions
Service	Measure	
Medical	Patient Stay	$\frac{aX_1 + bX_2 + \ldots kX_n}{gY_n + hZ + iQ}$
	Ambulatory Clinic Visits	$\frac{aX_1 + bX_2 + \ldots kX_n}{gY_n + hZ + iQ}$
Surgical	Patient Stay	$\frac{aX_1 + bX_2 + \ldots kX_n}{gY_n + hZ + iQ}$
	Ambulatory Clinic Visits	$\frac{aX_1 + bX_2 + \ldots kX_n}{gY_n + hZ + iQ}$
Gynecology	Patient Stay	$\frac{aX_1 + bX_2 + \ldots kX_n}{gY_n + hZ + iQ}$
	Ambulatory Clinic Visits	$\frac{aX_1 + bX_2 + \ldots kX_n}{gY_n + hZ + iQ}$
Pediatrics	Patient Stay	$\frac{aX_1 + bX_2 + \ldots kX_n}{gY_n + hZ + iQ}$
	Ambulatory Clinic Visits	$\frac{aX_1 + bX_2 + \ldots kX_n}{gY_n + hZ + iQ}$
Other	Patient Stay	$\frac{aX_1 + bX_2 + \ldots kX_n}{gY_n + hZ + iQ}$
	Ambulatory Clinic Visits	$\frac{aX_1 + bX_2 + \ldots kX_n}{gY_n + hZ + iQ}$
Obstetrics	Deliveries	$\frac{aX_1 + bX_2 + \ldots kX_n}{gY_n + hZ + iQ}$

[1] See explanation of notation at Exhibit II-6

Exhibit II-6

Notation Used in Exhibits II-2 Through II-5

NOTATION	DEFINITION
aX_1	Amount of products of department 1 required
bX_2	Amount of products of department 2 required
kX_m	Amount of products of department m required
X_1, X_2, X_m	Units of product output denoted for each of the n departments
a, b, k	Coefficients denoting amount of X products required
gY_n	Amount of personnel time required, by category
hZ	Amount of material required
iQ	Amount of equipment required
Y_n	Units of time for each personnel category
Z	Measure of materials
Q	Measure of equipment usage
g, h, i	Coefficients denoting amount of each resource required
n	Subscript representing the 3 personnel categories

resources. These three elements of the marginal cost model are incorporated into the following:

- Table of Coefficients
- Departmental Tables
- Resource Cost Tables

Each of these tables is described in the remainder of this chapter.

Table of Coefficients

This table contains the specified relationships between the departmental products and patient categories. The left side of the table is the array of patient types classified by beneficiary category, service category, and service measure. The hospital departments are arrayed along the top of the table. These include five inpatient departments, five outpatient departments, four direct patient care ancillary departments, and five indirect product centers. Exhibit II-7 illustrates a blank Table of Coefficients.

In operation each cell of the table will contain the number of products of each department required to serve one patient classified in the categories along the left side for a given military treatment facility. For example, one medical active duty patient stay might require 5.7 bed days, 5.16 X-ray films exposed, 482.67 weighted laboratory procedures, 17.1 meals, 171.13 pieces of linen, and so forth.

For most departments only one coefficient is necessary; however, in certain outpatient departments, more than one clinic, each with its own resource usage patterns, compose the department. For example, the department of Medical Clinics may be composed of five separate clinics while the department of Surgical Clinics may be composed of ten. Since each component clinic of each department is utilized at a different rate by different beneficiaries, and each clinic has different staffing patterns, each coefficient must be developed separately.

Many of the cells will also be blank for several reasons. Since the hospitalization departments are service and inpatient specific, coefficients for each of these departments are associated only with corresponding patient types. For example, coefficients relating the use of the products of the department of Medical Hospitalization (bed days) to specific patient types would generally be found only in cells corresponding to medical patient stay

PASSING FACTS			DEPARTMENTS									
BENEFICIARY	SERVICES	MEASURES	MED HOSP.	SURG. HOSP.	OB/GYN HOSP.	PEDS. HOSP	OTHER HOSP	MED CLINICS	SURG CLINICS	OB/GYN CLINICS	PEDS CLINICS	OTHER CLINICS
ACTIVE DUTY	Medical	Patient Stay Inpatient Clinic Visits Ambulatory Clinic Visits										
	Surgical	Patient Stay Inpatient Clinic Visits Ambulatory Clinic Visits										
	Obstetrics	Deliveries										
	Gynecology	Patient Stay Inpatient Clinic Visits Ambulatory Clinic Visits										
	Other	Patient Stay Inpatient Clinic Visits Ambulatory Clinic Visits										
DEPENDENTS OF ACTIVE DUTY	Medical	Patient Stay Inpatient Clinic Visits Ambulatory Clinic Visits										
	Surgical	Patient Stay Inpatient Clinic Visits Ambulatory Clinic Visits										
	Obstetrics	Deliveries										
	Gynecology	Patient Stay Inpatient Clinic Visits Ambulatory Clinic Visits										
	Pediatrics	Patient Stay Inpatient Clinic Visits Ambulatory Clinic Visits										
	Other	Patient Stay Inpatient Clinic Visits Ambulatory Clinic Visits										
RETIRED	Medical	Patient Stay Inpatient Clinic Visits Ambulatory Clinic Visits										
	Surgical	Patient Stay Inpatient Clinic Visits Ambulatory Clinic Visits										
	Gynecology	Patient Stay Inpatient Clinic Visits Ambulatory Clinic Visits										
	Other	Patient Stay Inpatient Clinic Visits Ambulatory Clinic Visits										
DEPENDENTS OF RETIRED AND SURVIVORS	Medical	Patient Stay Inpatient Clinic Visits Ambulatory Clinic Visits										
	Surgical	Patient Stay Inpatient Clinic Visits Ambulatory Clinic Visits										
	Obstetrics	Deliveries										
	Gynecology	Patient Stay Inpatient Clinic Visits Ambulatory Clinic Visits										
	Pediatrics	Patient Stay Inpatient Clinic Visits Ambulatory Clinic Visits										
	Other	Patient Stay Inpatient Clinic Visits Ambulatory Clinic Visits										

PATHOLOGY	PHARMACY	FOOD SERVICE	ADMINISTRATION	LINEN	MED. MATERIAL	MED. MAINT.	AMBULANCE	

patient types. The five clinics departments are also service specific such that coefficients relating the use of a clinic department's products to specific patient types are not found in cells corresponding to unrelated services. For example, a coefficient for surgical clinics would not be required in a gynecology patient cell. Finally, food services will normally not be used by ambulatory clinic visit patient types. Therefore coefficients relating the use of this department's products to patient types should be only in cells corresponding to patient stay.

Departmental Tables

In the production function approach, three types of resources required to produce departmental products and ultimately serve patients were specified: personnel, equipment and materiel. Since the unit of service provided by materiel resources was defined in terms of dollars and considered purely variable it is not necessary to separately account for their usage by specified patients outside of cost tables. However, personnel and equipment resources provide services independent of their costs. A second element of the model, therefore, accounts for these services. Personnel and equipment resource departmental tables specify the amount of each resource type required to produce departmental outputs.

Although each resource type provides variable input to the production of departmental outputs, the resources themselves can be purchased only in whole units. For example, each CAP (i.e., College of American Pathologists) weighted unit produced by the department of Pathology requires approximately one minute of time from a laboratory technician. But if the department produced from one to 10,400 CAP weighted units per month it would still need one technician because he can be acquired only as a whole unit with that range of capacity. The departmental tables are so constructed as to reflect this step-wise nature of personnel and equipment resources.

Each departmental table starts from a base point defined as the minimum staffing or equipment level required to establish the department.* The next point in the table is the product output which is the maximum sustainable product output level of that mix of minimum resources. To increase departmental output beyond this level, an additional resource must be acquired. This additional resource, however, provides the capacity to produce a given amount of additional departmental products before a second additional resource is required.

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*Staffing levels were determined from the U.S. Army Staffing Guide for Meddacs.

In the example at Exhibit II-8, the seven personnel resources associated with zero product output are the minimum staffing level required to staff an operating room. They have the capacity to produce up to three episodes of surgery per month. With the acquisition of a Senior OR Specialist, however, the operating room can sustain levels of output between four and 19. But in general, no more than 19 episodes of surgery per month can be sustained without acquiring a ninth resource (OR Specialist) which provides the capacity to produce up to 35 episodes of surgery.

The table then is so constructed as to be additive and discrete. Graphically, this same table can be represented as in Exhibit II-9. The table is additive in that in order to produce up to nineteen episodes of surgery, the operating room needs the seven resources in the base plus a Senior OR Specialist. In order to produce up to twenty-five episodes, an OR Specialist must be added to the previous eight resources. The table is discrete in that whether the operating room needs to provide four, 19 or any number of episodes of surgery between four and 19, a whole resource (i.e., the Senior OR Specialist) must be acquired. Fifteen episodes of surgery can be said to be the range of this resource's capacity and nineteen episodes of surgery can be said to be the constraint on the mix of eight resources. That is, the seven resources in the base plus the Senior OR Specialist are constrained from producing more than 19 episodes of surgery (on a sustained basis) without a ninth resource (OR Specialist).

This departmental table is a series of constraint points, in terms of the product output of the department, at which resources must be acquired to sustain up to a given level of additional products. In Exhibit II-8, these constraint points are shown in the left column. The resources in the second column are those that at each constraint point need to be purchased to sustain production up to the next constraint point. The third and fourth columns are used to calculate the cost of each resource.

There is at a minimum one table for each department and subdivided department in the Table of Coefficients to account for personnel resource utilization. In addition, there should be one table for each type of physician (medical, surgical, OB/GYN, and other). Physician tables should be included separately to account for the reality that although physicians are authorized separately on the basis of bed days and on clinic visits, few physicians spend their time exclusively in either inpatient or outpatient care. All internists, for example, work on the medical ward and in the internal medicine clinic regardless of where they are slotted in a Table of Distribution and Allowances (TDA). Therefore, the tradeoffs between the two types of care must be shown on one scale such that a physician constraint in inpatient care may "borrow" underutilized physician time from outpatient clinics. The scale may be in terms of clinic visits as the product output of

Exhibit II-8

Example of a Personnel Resource Departmental Table
Surgical Hospitalization II (Operating Room)

Product Output	Resource Constraint		
	Type [1/]	Code [1/]	Grade
0	Base = 4 Nurses	R-2	04/03/02
	Chief OR Specialist	R-3	E-7
	Senior OR Specialist	R-3	E-6
	OR Specialist	R-3	E-5
3	Senior OR Specialist	R-3	E-6
19	OR Specialist	R-3	E-5
35	OR Assistant	R-3	E-4
51	OR Specialist	R-3	E-5
67	Senior OR Specialist	R-3	E-6
83	OR Assistant	R-3	E-4
99	Clinical Staff Nurse	R-2	02
115	OR Specialist	R-3	E-5
131	Clinical Staff Nurse	R-2	02
154	Reports Clerk	R-3	E-4
182	Senior OR Specialist	R-3	E-6
209	Clinical Staff Nurse	R-2	02
237	Assistant Chief OR Specialist	R-3	E-6
	Assistant Chief OR Nursing (Upgrade)	R-2	03-04
	Chief OR Nursing (Upgrade)	R-2	04-05
264	OR Assistant	R-3	E-4
292	OR Specialist	R-3	E-5

Exhibit II-8 — Cont.

Product Output	Resource Constraint		
	Type	Code	Grade
319	Clinical Staff Nurse	R-2	02
347	Senior OR Specialist	R-3	E-6
	COMPOSITE	R-3	E-6

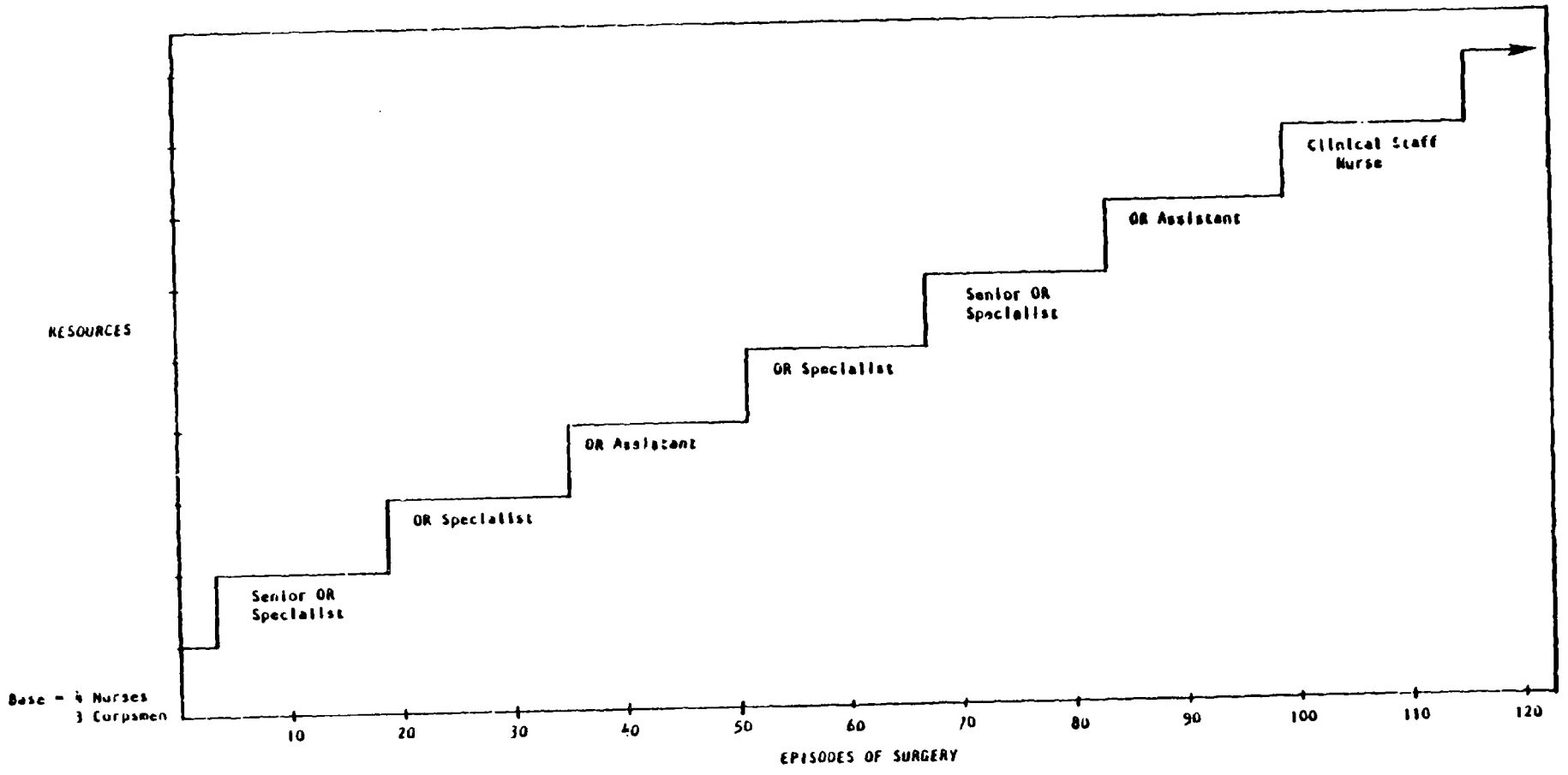
Exhibit II-8 -- Cont.

[1]"Type" refers to the actual designation of the resource while "code" refers to the three types of personnel resources as follows:

- Officers with Medical Specialties - R-1
- Other Officers - R-2
- Enlisted Personnel - R-3

Exhibit II-9

Graphic Illustration of a Departmental Table



physicians and all inpatient requirements need only be translated into clinic visits to determine physician constraints.

Cost Tables

A third set of tables delineate the specific costs of resources which may be acquired to increase the productive capacity of individual departments. Due to the coding structure utilized in the departmental tables, all resources may be defined in terms of three categories of personnel resources, equipment, and material. The cost of each of these types of resources are delineated in three tables: personnel, equipment, and material.

The personnel resource cost table is a two-dimensional matrix with the three categories defining one dimension and the military pay grade structure defining the second. The cells then contain the dollar cost of a personnel resource type at defined pay grades. Military personnel cost figures are derived from the standard rates for costing military personnel services adjusted for:

- Retirement
- Wage Acceleration
- Physician Variable Incentive Pay

Civilian personnel are accounted for in a separate table, similarly structured, but using civilian rates of compensation at pay grades equivalent to military pay grades.

Another table is needed for equipment costs to account for the various types of equipment which may be acquired at equipment constraint points. This table is merely a list of equipment and their associated dollar costs adjusted for depreciation. Since all present equipment in a hospital has been purchased, and their associated costs expensed, only the costs of additional equipment associated with additional departmental product output are considered. And such costs should reflect the latest price.

The materiel cost table is merely the average materiel cost per patient type. It is calculated under the assumption that all materiel costs are variable. Therefore, the materiel costs associated with additional patients served are the average materiel costs per patient type times the number of incremental patients.

Marginal Cost Model Summary

In summary a marginal cost methodology has been developed and tested with several Army medical treatment facilities. This marginal cost model provides the Army with a significant tool in calculating marginal costs. The contractor recognizes that the methodology is first draft and thus it is expected that subsequent changes will be made. However, the contractor does believe that this model fulfills the basic requirements of this study and provides the Office of The Surgeon General with a powerful and accurate management tool.

III. RELATED ISSUES

As part of this study two related issues were undertaken. The first involved a comparison of Letterman Army Medical Center with Non-Medical Centers and the second involved automating the marginal cost methodology.

COMPARISON OF LETTERMAN ARMY MEDICAL CENTER WITH NON-MEDICAL CENTERS

The analysis of the marginal costs of health care delivered at Letterman Army Medical Center (LAMC) has provided a basis for examining the differences in care provided at a tertiary care facility with that provided patients at non-medical centers (i.e., Meddacs). Since LAMC is considered a tertiary care facility, the hypothesis is that the care provided at LAMC is different than that provided at the other facilities. The comparison of LAMC with the other facilities was accomplished by:

- Constructing the marginal cost model embodied in the methodology manual for LAMC as was done for the Meddacs
- Develop the marginal cost of care at LAMC
- Compare LAMC with the Meddacs using a series of costs, coefficients, costs per bed day and coefficients per bed day.

The remainder of this chapter presents the methodology used to make the relevant comparisons and a series of tables presenting the results of the analysis.

Comparison Methodology

This section presents the specific areas of comparison between LAMC and the Meddacs and a description of the statistical techniques employed.

Areas of Comparison. In general, we believe that two sets of factors may impact the hypotheses. We know that the average length of stay (ALOS) for most patient types is higher at LAMC than at the Meddacs. This factor may be related to the tertiary care function. This was tested by comparing the ALOS at LAMC with that of the Meddacs by patient type and determining if, at a 95% confidence level, the differences are significant.

A second factor which may impact the hypothesis of whether the care provided at LAMC is significantly different from the care provided at the Meddacs is the amount of ancillary services required by patients. This issue is primarily directed at the use of radiology, pathology, and pharmacy services by patients. These factors were examined by comparing the coefficients for these departments at LAMC with those at the other Meddacs and by comparing the coefficients per bed day.

Another factor which impacts our hypotheses is whether the marginal costs of health care delivered at LAMC are different from the marginal costs of health care delivered at the Meddacs on the same basis. That is, using the same methodology to construct the model and the marginal costs, are the costs of care at LAMC different from those of the Meddacs. This may be tested by comparing the marginal costs of health care delivered at LAMC with those delivered at the Meddacs. Two costs were compared by:

- The total marginal costs per patient served
- The marginal costs per bed day.

Statistical Techniques. For each selected comparison point the analysis included the determination of whether or not LAMC values were significantly different from the Meddacs at a 95% confidence level. This was determined according to the following relationship:

$$P\left[\bar{X} - t_{\alpha}\left(\frac{s}{\sqrt{n}}\right) \leq \mu \leq \bar{X} + t_{\alpha}\left(\frac{s}{\sqrt{n}}\right)\right] \leq 1-\frac{\alpha}{2}$$

where:

$\bar{X}$ = mean value of the Meddac sample

t_{α} = Two tailed t. statistic with n-1 degrees of freedom ($\alpha = .05$)

$$s = \sqrt{\frac{\Sigma(X-\bar{X})^2}{n-1}}$$

L = the observed LAMC value

The LAMC facility report contained a series of tables comparing LAMC with the other Meddacs. Each table includes the observed LAMC values, mean Meddac values, the standard error of the Meddac sample, and the upper and lower confidence limits at a 95% confidence level. The following tables were included:

- Table 1 - Marginal Cost Comparison
- Table 2 - Marginal Cost per bed day Comparison
- Table 3 - ALOS Comparison
- Table 4 - Comparison of Pathology Coefficients
- Table 5 - Comparison of Pathology Coefficients per bed day
- Table 6 - Comparison of Radiology Coefficients
- Table 7 - Comparison of Radiology Coefficients per bed day
- Table 8 - Comparison of Pharmacy Coefficients
- Table 9 - Comparison of Pharmacy Coefficients per bed day

Summary and Conclusions

The average length of stay (ALOS), as displayed at LAMC is higher than at the Meddacs for all patient types. Using a 95% confidence level, it has been determined that the differences are significant in every case. It was supposed that the amount of ancillary services required by patients at LAMC would vary significantly from the care provided at the meddacs. The ancillary services tested were radiology, pathology, and pharmacy. In the comparison of these coefficients, it was found that most of the values attributed to LAMC were significantly higher than the Meddac coefficients. In only the comparison of pharmacy coefficients (Exhibit IV-8) do 37% of the coefficients fall within the 95% confidence level limits. When comparing the three sets of coefficients per bed day for the ancillary services, it was determined that only in the comparison of pathology coefficients per bed day is there a small percentage (25%) of LAMC values that fall within the given limits, whereas 75% of the LAMC values are significantly different. We find tha 62% of the LAMC values do fall within the confidence limits, and therefore, are not significantly different.

We have used two marginal costs comparisons to determine the differences between LAMC and the Meddacs. In the first test, we have compared the total marginal costs per patient served wihin the two types of facilities. The indications are that there are only 31% of the LAMC marginal costs which fall within the two confidence limits set. The second test was to compare the marginal costs per bed day. In this comparison, as well, it was determined that a small percentage (25%) of LAMC values fall within the limits of allowable error and most of the costs, therefore, are significantly different. On the basis of these two tests, it can be determined that the marginal costs for care provided to patients of LAMC are different, and higher, than thse marginal costs for care provided to patients in non-medical centers.

On the basis of these comparisons it is apparent that the methodology as developed for the Meddacs cannot be strictly applied to a medical center and arrive at reasonable costs. There are significant differences in the care delivered at LAMC and the Meddacs. The ALOS and LAMC is higher as is the marginal cost per bed day. That is, not only do patients at LAMC stay longer but the care received per bed day is more intensive. This could be due to the fact that it is a tertiary care facility which treats specialized patients and that it has a teaching mission. These factors can account for the additional expense per bed day as well as the increased ALOS. To make the methodology applicable to a medical center, it will be necessary to identify and quantify the specific characteristics that account for the differences between Meddacs and Medical Centers and to develop a methodology to factor out these differences.

AUTOMATION OF MARGINAL COST METHODOLOGY

Once the marginal cost methodology was developed, it was decided to attempt to automate this methodology. This study team reviewed the manual methodology with the purpose of designing an automated methodology.

The Automated Marginal cost Model was to be composed of three contiguous modules which calculated the marginal costs.

Module A was to accept as input the necessary files in order to determine the department output-products actually produced and the output required to serve basic plus additional patients were to be passed to Module B.

Module B was to provide the calculated results for determining the marginal costs of all incremented patients on a department basis.

Module C was to accept the output of Module B and an additional file as input and use those values to generate the following reports:

- Departmental Consolidation Table Report
- Marginal Cost Estimates Report
- Alternative Study Comparison Report
- Marginal Staff Requirement Report

Each report was to be a function of one facility. Each of the modules was to produce results for one facility at a time.

The first two reports were to be the same format as those in the individual facility reports. The last two reports were designed respectively to compare the marginal costs of different incremental workloads and to show the number of additional staff required to serve the incremental workload by department.

The three modules and associated files were designed and programmed and provided to the Army in binders. Systems testing was not completed prior to contract end and thus the automated model cannot be used to calculate marginal costs at this time. during the course of automating the marginal cost model several problems relating to the automation and not the methodology itself were encountered. In particular, the following factors hindered progress:

- The marginal cost methodology was significantly more detailed with more variables to program than originally anticipated.

- The facility data were much more complex in terms of applying them to a computer model than originally expected.

It should be pointed out that the automation of this marginal cost model offers the Army a substantially quicker means of calculating the voluminous numbers required. However, it appears that one could automate approximately 80% of these calculations rather easily while the remaining 20% could be calculated manually. Thus it is strongly recommended that the Army consider modifying the existing computer programs so that they calculate the major segment of calculations.

IV. SUMMARY AND CONCLUSIONS

SUMMARY

The Orkand Corporation submitted the following technical reports to the COTR:

- Methodology Manual dated December 23, 1977. This document detailed the methodology and procedures for determining the marginal costs of health care in an Army Medical Treatment Facility. It also presents the operational definition of marginal cost for the purposes of this study.

- Reports presenting marginal costs calculated in accordance with the established methodology were prepared for the following facilities:

  - DeWitt Army Hospital, Ft. Belvoir, VA
  - McDonald Army Hospital, Ft. Eustis, VA
  - Kenner Army Hospital, Ft. Lee, VA
  - Cutler Army Hospital, Ft. Devens, MA
  - U.S. Army Hospital, Ft. Carson, CO
  - Hays Army Hospital, Ft. Ord, CA
  - Darnell Army Hospital, Ft. Hood, TX
  - Letterman Army Medical Center, San Francisco, CA

  Each of these reports contained specific marginal costs by patient type and a comparison of these calculated costs to those prevailing in civilian facilities. The Letterman Army Medical Center report presented an assessment of the extent to which the methodology could be generalized for application to Army Medical Centers as well as Meddacs.

- A final report discussing the methods employed, data utilitied, deliverable reports, and general study conclusions.

In the course of model development, and particularly during application of the methodology in producing facility-specific marginal costs, an anomaly appeared. A few hospital departments were found to be "overproducing"; that is, actual staffing levels produced workload at a higher level than the staffing standard would seem to allow, even when adjusted for local appraisal factors. Theoretically, rectification should be necessary to bring staffing levels to the standard in order to continue producing at the (then) current levels. For the purposes of this study, rectification was assumed to have

been made in those few instances where departments overproduced. While rectification costs are not marginal costs, OTSG requested that the contractor compute and display three marginal cost "cases" for each facility:

Case I. These are the incremental costs of serving each patient type; included are the costs of full staff rectification. That is, this case includes the costs of additional resources required (theorectically) to serve baseline patients, regardless of incremental patients.

Case II. This case includes only the costs of resources required to serve the incremental patients. It includes no costs of staff rectification.

Case III. This case prorates that portion of rectification costs which represents excess capacity to the marginal cost. Thus, Case III includes some, but not all of the costs of rectification.

The calculation of three marginal costs instead of just one provides a large measure of flexibility in applying the results of the analysis. Depending upon what portion of rectification costs are relevant in any specific application of the methodology, it is possible to select alternative cases and include the appropriate level in the final calculations. The methodology also permits varying levels of department staffing, incremental patients, and baseline patients. This contributes to the flexibility of the methodology by ensuring that these factors are not fixed and can readily adjust to changing workloads and staffing levels in individual facilities.

CONCLUSIONS

In general, the study concluded that, at the margin, it is significantly less expensive to provide treatment in an Army facility rather than a civilian medical treatment facility. Exhibit IV-1 highlights this conclusion by showing that in the overwhelming majority of cases, the Meddac costs are significantly lower than corresponding civilian costs. This exhibit was developed using Case II marginal costs. Of the three alternatives, Case II most accurately presents the marginal costs. It includes only the cost of resources required to serve the incremental patients. In nearly all cases studied, the Case I and III marginal costs were also lower in the Meddacs. This is true even though these two cases include a level of cost not strictly associated with the incremental workload.

The Orkand Corporation is confident that the results of this study are accurate and that the cost figures calculated according to the methodology developed for this study are both valid and reliable. The methodology employed is replicable by using the methodology manual developed during this study. The methodology accounts for all relevant cost components and for the organizational and operational differences between facilities.

Exhibit IV-1

Summary Comparison of Meddac and CHAMPUS Costs

Patient Group	Percent of Meddac Costs Less Than Half of CHAMPUS Costs	% of Meddac Costs Less than 40% of CHAMPUS Costs	% of Meddac Costs Less Than 30% of CHAMPUS Costs
Inpatient	90.6	84.4	67.7
Outpatient	98.9	93.6	85.1
OB (Deliveries)	100	85.7	78.6