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A STUDY OF THE AVERAGE COST OF
OBSTETRIC SERVICES DELIVERED AT
WOMACK ARMY COMMUNITY HOSPITAL,
FORT BRAGG, NORTH CAROLINA

A Graduate Research Project
Submitted to the Faculty of
Baylor University
In Partial Fulfillment of the
Requirements for the Degree

of

Master of Health Administration

by

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CHAPTER I

INTRODUCTION

Womack Army Community Hospital (WACH) averaged 137 live births per month from October 1981 to March 1984. Certificates of nonavailability for obstetrical care have averaged 210 per month over the same period. Attempts to recapture obstetrics patient work load and minimize the cost of services provided to our beneficiaries outside of Womack pushed the number of births to 1783 in 1984, an average of 148.58 per month. Certificates of nonavailability declined to 163.75 per month in 1984.

In fiscal year 1983 (FY83) WACH issued 2,486 certificates of nonavailability authorizing these potential clientele to access obstetric services elsewhere using the Civilian Health and Medical Program of the Uniformed Services (CHAMPUS). The FY83 average cost per obstetrics patient admission resulting from this traditional CHAMPUS delivery system was \$2,258. The approximate total costs of these CHAMPUS expenditures was \$5.6 million. In 1984, the cost per patient admission jumped to \$2811.48 while the number of certificates of nonavailability issued to beneficiaries to use CHAMPUS declined to 1964. The approximate total cost of these CHAMPUS expenditures was \$6.3 million.

CHAMPUS was chartered by the Congress of the United States in Public Law 95-861 to extend the range of services and providers available to

Department of Defense (DOD) eligible beneficiaries and thus ease existing inequities in access to services. The trend in the legislative and regulatory evolution of CHAMPUS subsequent to its inception has been the expansion of the benefits authorized by the program. Concurrently, the cost of health care services has spiraled with rates of inflation consistently in excess of the consumer price index. This has resulted in CHAMPUS costs exceeding \$1 billion per year since 1982 and has earned the ire and scrutiny of many congressional and DOD leaders searching for cost containment measures.¹

These sentiments are embodied in the Carlucci Memorandum² and Public Law 98-94. Mr. Carlucci, the Deputy Secretary of Defense, directed that the uniformed services take steps to contain costs. Public Law 98-94 embodies a legislative mandate for innovation by CHAMPUS and DOD to contain costs.

In response to these stimuli, the Office of CHAMPUS is considering the establishment of a preferred provider organization (PPO) contractual relationship for obstetric services in the WACH catchment area.³ This CHAMPUS-PPO delivery system could decrease the cost to CHAMPUS of delivering the contracted obstetric services via prenegotiated payment systems. Concurrently, the PPO gains increased market share referral patterns and case mix specialization potential. The certificate of need application submitted to the regional health services agency by the leading PPO contender (a for-profit hospital) requesting permission to build and operate a birthing center attests to the economic feasibility of this relationship from a PPO perspective.

WACH is economically vulnerable in this "cost containing" maneuver. Unless the CHAMPUS-PPO contract is carefully negotiated, variations in the CHAMPUS-PPO contractual delivery system have the potential to change the case mix (i.e., complexity and risk of complication) of obstetric patients treated at WACH. This in turn may influence the average cost per obstetrics patient treated at WACH. The elevation of the average cost per obstetric patient treated at WACH in order to contain the government's cost for obstetrics patients utilizing CHAMPUS may negate the congressional and DOD goal of real cost containment for health care in the WACH catchment area.

STATEMENT OF RESEARCH

To determine if the cost per patient of obstetric services at WACH would increase significantly after the implementation of a CHAMPUS-PPO delivery system.

OBJECTIVES

1. Complete a literature survey pertinent to:
 - a. CHAMPUS
 - b. Preferred provider organizations
 - c. Systems model design
 - d. Cost analysis
 - e. Obstetric delivery systems
2. Model the existing obstetrics services delivery system to identify the cost variables present.

3. Determine the case mix (complexity and risk) composition of the WACH obstetrics population that is treated in house.
4. Determine the significant cost variables in predicting the cost of delivering obstetric services within the present delivery system.
5. Determine the average cost per patient for obstetric services within the existing delivery system at WACH.
6. Model the anticipated WACH obstetric service (post-CHAMPUS-PPO implementation) to identify the reasonably identifiable cost variables it would contain and the case mix composition of the population served.
7. Determine the significant cost variables specific to the anticipated WACH obstetric service system (post-CHAMPUS-PPO implementation).
8. Determine the predicted average cost per patient for obstetric services within the WACH obstetric service system (post-CHAMPUS-PPO implementation) as a predicted standard of comparison.
9. Determine if the average cost per patient of obstetric services delivered at WACH with traditional CHAMPUS referral systems will significantly increase after implementation of a CHAMPUS-PPO delivery system.

CRITERION

The difference between existing obstetric service average cost at WACH and the predicted average cost standard of comparison for obstetric service delivery at WACH (post-CHAMPUS-PPO implementation) must be significant at $\alpha = 0.10$ to be accepted as an indication of an increase in average cost per obstetric case.

As Daniels points out in his text, the purpose of hypothesis testing is to aid the researcher in reaching a decision concerning a population by examining a sample from that population. The level of significance (α) selected indicates the probability of rejecting a true null hypothesis (Type I error) that the researcher is willing to accept.⁴ If the null hypothesis that the cost of delivering obstetrics services at Womack would decline or remain the same after the implementation of a CHAMPUS-PPO birthing center was erroneously rejected, it would mean the potential loss of considerable potential savings to the Department of Defense due to unnecessary defensive organization behavior by WACH. If the null hypothesis was erroneously accepted (Type II error), then WACH would be vulnerable to elevation of its cost of delivering obstetric services. The level of significance selected ($\alpha = 0.10$) statistically represents the researcher's concern for the protection of WACH from financial injury.

ASSUMPTIONS

1. The data collected by the Uniformed Chart of Accounts (UCA) system since 1982 is accurate.
2. The indirect cost of delivering obstetric services at WACH will not change significantly due to a CHAMPUS-PPO delivery system change.
3. Manpower and facility resources at WACH will not change as a result of or during a CHAMPUS-PPO delivery system change.
4. The demand for obstetric care at WACH will not change significantly due to the change in the CHAMPUS-PPO delivery system change.

5. The number of obstetric patients departing the WACH treatment system prior to completion of services equals the number arriving from other posts.

LIMITATIONS

1. There are no CHAMPUS-PPO systems currently in existence for study.
2. The WACH CHAMPUS-PPO system will not be in place until after this research project is completed.
3. The residency time frame limits studies to concurrent or retrospective approaches.
4. The costs associated with the care of the children post-delivery will not be considered.

WACH has a dual mission in the delivery of obstetrical health services. As a federal health care facility, it has a primary mission to deliver the maximum volume of services to the beneficiary population served within the constraints of its production functions, resource limitations, and quality of care parameters. Additionally, WACH has a training mission for Family Practice residents, nurse practitioners, and licensed practical nurses (91Cs). The health care delivery mission must be balanced with the training needs of these programs in all decision processes.

REVIEW OF THE LITERATURE

The literature investigation conducted to support this research was concentrated in five primary areas:

- 1) CHAMPUS
- 2) preferred provider organizations

- 3) systems model design
- 4) cost analysis
- 5) obstetric delivery systems.

These areas are developed as they pertain to the research problem below.

CHAMPUS

CHAMPUS, the Civilian Health and Medical Program of the Uniformed Services, is a health benefits program provided by the federal government of the United States. It extends the range of health care providers and services to eligible beneficiaries while sharing the cost of these benefits with the recipients. The program is designed to ease the cost of accessing health care services for beneficiaries by supplementing the military health care delivery system.⁵

CHAMPUS evolved out of a concern for the health of the dependents of active duty service members that can be traced to congressional legislation passed in 1884. To alleviate the inequities of access to the military and civilian health care delivery systems, the Congress passed legislation in 1956 authorizing the establishment of CHAMPUS. A matrix of the functional areas of CHAMPUS law, origins in public law, and corresponding organization within the United States Code of General Military Law is at Figure 1. As the CHAMPUS program grew in complexity, so did the policy and memoranda which guided its activity. In 1977, CHAMPUS activity became governed by Department of Defense Regulation 6010.8R, issued by the Assistant Secretary of Defense for Health Affairs. It is this

regulation that identifies those dependents of active duty service members and retired service members and their dependents that qualify for CHAMPUS benefits when their health care needs exceed the service capacity of any medical treatment facility and thus, Womack Army Community Hospital.⁶

Functional Area	Origin in Public Law (PL)	Gen Military Law US Code Sectional Location
A. Delineation of eligible beneficiaries, authorized services, and authorized providers	PL 85-861, PL 89-97 PL 89-614, PL 92-58	1074,1076,1077, 1079,1080,1083, 1084
B. Delineation of responsibility and authority (Department of Defense vs. Department of Health and Human Services)	PL 85-861	1073
C. Prevention of program duplication with Social Security Administration and private insurers	PL 89-97	1079
D. Cost containment	PL 89-188	1078,1081
E. Authorization of studies and demonstration projects	PL 98-94	1092

FIGURE 1-1. CHAMPUS Law, Origins and Organization in Military Law

In 1977, the Office of CHAMPUS (OCHAMPUS) was established as a field activity of the Secretary of Defense by DOD Directive 5105.46. The Director of CHAMPUS receives policy guidance and direction from the Assistant Secretary of Defense for Health Affairs and keeps CHAMPUS operations within legal and regulatory parameters. The OCHAMPUS organization administers the CHAMPUS program for the Department of Defense.⁷

The escalation of CHAMPUS health care cost (in excess of \$1 billion since 1982) resulted in political and economic motivation, as evidenced by the Carlucci Memorandum and Public Law 98-94, for CHAMPUS to achieve cost-efficient operations. The Carlucci Memorandum, issued on 8 November 1982 by Mr. Frank C. Carlucci as the Deputy Secretary of Defense, directed that exceptional steps be taken to reduce CHAMPUS expenditures. This memorandum made the position of the Department of Defense, as the legal proponent for CHAMPUS, clearly in support of cost containment innovation.⁸ Public Law 98-94, passed by Congress on 24 September 1983, directs "studies and demonstration projects on the health care delivery system of the uniformed services with a view to improving health care services." These studies and projects may include:

- 1) Alternative methods of payment for services
- 2) Beneficiary cost sharing
- 3) "Methods of encouraging efficient and economical delivery of health and medical care services."
- 4) Innovative approaches to delivery and financing of health and medical care services.
- 5) Alternative approaches to reimbursement for the administrative charges of health care plans.
- 6) Prepayment for medical care services provided to maintain the health of a defined population.

The composite effect of the Carlucci Memorandum and PL 98-94 is considerable latitude for changing CHAMPUS operations in the six areas enumerated above.⁹

Preferred Provider Organizations

Given the desire of CHAMPUS for cost containment, it is not surprising that they are investigating the use of preferred provider organizations in the WACH area as a means of more cost-effective health care services acquisition.¹⁰ Tibbitts and Manzano define a preferred provider organization (PPO) as a mechanism for financing, delivering, and/or marketing health care services. Within the PPO structure, the health care providers offer their services on a predetermined financial basis to the health care purchasers. The terms of remuneration are designed to include marketing incentives for the consumers which encourage selection of the organization's providers as the source of service to sponsored individuals and their third party payors.¹¹

The common characteristics of PPOs formed and operated to date and pertinent to this research are best developed in the literature by Mitlyng in 1983 and Tibbitts and Manzano in 1984.^{12, 13} These characteristics are:

- 1) PPO consumers have a choice of utilizing providers that belong to the PPO for accessing health care services or utilizing non-PPO providers.
- 2) PPOs are dependent upon elevated cost efficiency for long term competitive viability, thus utilization review and other cost containment programs are common facets of their operations.
- 3) The existence of economic incentives for consumers to utilize the "preferred provider" for access to services.

Schroer and Taylor trace the origin of the PPO concept to Blue Cross/Blue Shield.¹⁴ Although preferred provider organizations evolved from an idea that originated in the 1930s and 1940s, the earliest PPO became operational in the early 1970s and was a hospital-organized PPO offering services initially to its own employees.¹⁵ The interaction of the patient as a consumer, the provider, the third party payor/insurer, and the government has resulted in a major change in market forces prompting levels of competition and disequilibrium formerly unknown in the modern health care industry. The major factors contributing to this market disequilibrium were:

- 1) Physician and health care practitioner oversupply such as the 70,000 excess physicians by 1990.¹⁶
- 2) Hospital service oversupply such as 100,000 excess beds in 1982.¹⁷
- 3) Emerging alternative health care delivery systems.
- 4) Resource constraining government regulations, most auspiciously, Title VI to the Social Security Amendments of 1983 and its prospective payment system.
- 5) Vertical and horizontal integration of health care delivery systems.
- 6) Market stress due to the health care cost spiral.^{18,19}

Tibbitts and Manzano developed extensively the driving forces behind the emergence of PPOs.²⁰ The preferred provider impetus must also be viewed from the perspectives of the patient, provider, third party insurer/employer, and the government to bring it into focus. The patient as a health care consumer was finding the trend for first dollar insurance coverage to have reached its pinnacle in 1969 when 86% of the major employers in

America had no coinsurance or deductible provisions for inpatient services.²¹ Since 1979, full insurance coverage has decreased and cost sharing has increased creating a fertile environment for an incentive/disincentive system for health care benefit program selections. The patients' insulation from health care cost was crumbling. Reductions in government health care expenditures, prolonged recession and unemployment, and health care cost containment initiatives by employers resulted in elevated out-of-pocket health care cost to the patient at the point of utilization.²²

To the patient, the PPO has appeal because it has the potential for reducing the financial cost of accessing health care services while still allowing the patient an element of choice in the provider selection process.

Kodner's 1982 publication describes the impetus for PPO emergence from the provider's perspective.²³ The health care provider is also economically challenged in an environment marked by competition and disequilibrium. Reinforcement of referral patterns and protection of market share in an increasingly competitive market place are primary sources of impetus for the formation of PPOs. Case mix selectivity associated with PPO systems has the potential for capital investment and production function efficiency for providers confronted with prospective payment system reimbursement mechanisms. Given the proper market conditions, fee for service behavior and routine cost based reimbursement mechanisms will be traded off to gain or protect market share.

The impetus of the third party insurers and employers to utilize PPOs must be juxtaposed with that of the patient and providers. The insurance industry as the recipient of extensive cost shifting (\$5.8 billion, 1982) was feeling major financial losses--\$1.5 billion in 1978 and \$1.4 billion in 1979. Insurance premiums had increased 2900% per capita between 1950 and 1979 and companies were decreasing benefit packages to contain costs. Contrary to their desires to expand product lines, the insurance industry was losing its market share as major employers opted for alternative delivery systems such as self insurance or health maintenance organizations.²⁴

Employers were spending approximately \$1,000 per employee or \$130 billion (1983) for health care benefits. The Tax Equity and Fiscal Responsibility Act of 1982 (TEFRA) constrained their tax incentives in the health benefit arena and further motivated a third of the employers with labor management plans to self-insure.

Both parties wanted to decrease health care cost and regain some expenditure control via:

- 1) Reinforcing cost-effective providers.
- 2) Modifying employer-consumer behavior.
- 3) Improving information feedback systems.

The employer and the insurer were searching for an employee health benefit compromise that would allow more provider selection latitude than an HMO and would concurrently promote better cost containment than traditional fee-for-service health care delivery systems.

The federal government spent \$74 billion on health care in 1982 and is projected to spend \$144 billion in 1988. By 1990, the federal government will be the third party payor for 32% of the health care market. The TEFRA, the Omnibus Budget Reconciliation Acts of 1981 and 1982, and Title VI of the Social Security Amendments of 1983 all contain attempts to decrease the rate of spiraling federal government expenditures for health care. The resource constraint and reimbursement behavior changes of the federal government promise to keep the industry in a state of disequilibrium and turbulence that will foster competition and innovation for the foreseeable future.^{25,26}

The organization and structural models of PPOs are dictated by the mission and goals of the parent entity, the internal and external environment, and the operational considerations specific to the region. Thus, PPOs are characteristically differentiated in organization and structure. There are three major types of PPO organizations: provider-based, payor-based, and entrepreneur-based PPOs. Of concern to this research is the payor-based PPO which is an entity or product line provided by the insurance industry, self-insured employers, or health benefits trust.^{27,28}

Patient channeling incentives and disincentives promoting use of the PPO's providers are balanced with the negative connotation of lack of consumer choice and corresponding marketing backlash and the elevation of patient care liability. This is a particularly challenging problem for CHAMPUS because the charges for a routine pregnancy and delivery are treated as a unit and usually will cost a dependent of an active duty service

member only \$25.00 as long as the provider accepts the rates of CHAMPUS reimbursement. This charge is currently independent of the choice of provider.²⁹

The most essential component found in most PPOs is a blend of quality of care, accessibility of services, and cost effectiveness. The major consumers of PPO services today are employers trying to contain benefit costs very much like the Department of Defense. The employers' primary concern in selecting a source of health care services was quality (69%), accessibility for their employees, and finally, cost reduction. "The real question is what a PPO network is able to do in the monitoring and delivery of health care to make it a more palatable product for the employee and the employer." A PPO seeking discounts for services on a prospectively determined payment system must contractually align itself with cost effective providers. These providers must be able to deliver health care services at state-of-the-art standards of care and still make a profit after a discount is given. A significant decline in the quality of care places the patient, provider, employer, and PPO at risk in different but equally serious ways.³⁰

The legal dimension of PPOs is best developed in the literature by Epstien in 1983 and by Tibbitts and Manzano in 1984. The fundamental laws impacting on the health care industry, and specifically, PPOs have not changed dramatically in this decade. However, as the perceptions and corresponding relationships between the elements of our society and health care providers have changed, so has the interpretation and application of the law changed. These relationships span a spectrum from federal to individual.

Within federal law "... The Sherman Act, Section 1, prohibits contracts, combinations, and conspiracies in restraint of trade. Any activity, discussion or agreement between competing providers concerning price, division of market, allocation of service or territories, or exclusive dealing between providers and purchasers is subject to scrutiny as anti-competitive action. Section 2 of the Sherman Act discusses and prohibits monopolization, attempts to monopolize, and conspiracies to monopolize." Recent cases making this law clearly applicable to the health care industry are:

- 1) Arizona vs Maricopa County Medical Society
- 2) National Gerimedical Hospital and Gerontological Center vs Blue Cross of Kansas City
- 3) Hospital Building Co. vs Trustees of Rex Hospital

The Fair Trade Commission Act prohibits unfair methods of competition and unfair or deceptive acts or practices, while the Clayton Act with its amendment, the Robinson-Pactman Act, focuses on the delivery of goods and thus "may be applicable in the formation of hospital joint ventures and unlawful mergers." Given these legal parameters limiting anticompetitive behavior, Group Life and Health Ins. Co. vs Royal Drug Co. provides clear latitude for PPO operations as long as there is not evidence or anticompetitive conspiracy, "per se" violations, or violation of the "rule of reason."^{31,32}

At the 22 March 1985 meeting of the American Bar Association, the Assistant Attorney General, J. Paul McGrath, encouraged the development

of preferred provider arrangements. He assured members that preferred provider arrangements controlled by insurance companies, third-party payors, or independent contractors have "real competitive potential" and "little risk of anticompetitive harm."³³

Maintaining focus upon the payor-based PPO, as a federally chartered operation CHAMPUS has exemption from State laws governing securities, corporate operations, insurance business practices, and health care specific laws and regulations. Malpractice litigation is a very different entity. As Medi Cal has already learned, shielding the PPO and parent organization from malpractice suits is critical. Organization behavior essential to the limitation of liability noted by Tibbitts and Manzano and pertinent to OCHAMPUS are:³⁴

- 1) Maintenance of providers in an independent contractor status.
- 2) Provision of consumer choice alternatives.
- 3) Balance of quality control, utilization control, and medical necessity policies.
- 4) Provider screening and malpractice insurance prerequisites.

Hospital Cost Analysis

Judith R. Lave sets the stage for a review of the literature pertaining to hospital cost analysis by establishing some definitions for very prevalent terms in this area of academia. Total cost is defined as the total money expended on producing some level of output. Average cost is the cost per unit of output. Variable costs are those directly related to the production of some output. Fixed cost is the cost that would have been incurred even if no output had been produced.³⁵ "It is

generally observed that the majority of a hospital's costs are fixed costs; that is, most of a hospital's costs are determined once the size of the plant (number of hospital beds) and the number of facilities and services are determined." This is estimated to be in the range of 75% of total costs by Ray E. Brown and Paul J. Feldstein.^{36,37}

Judith R. Lave examines the statistical analyses used to study hospital costs and identifies regression and factor analysis as the methods most commonly used.³⁸

In investigating the literature for a foundation in hospital cost analysis, the author most frequently noted for studies in hospital cost behavior was M. Feldstein. In his study of 177 acute care hospitals, he used departmental proportions of total hospital business as surrogate measures of case mix and then used multiple regression equations to relate case mix to the average cost per week. He found case mix to explain about 25% of the variation in average cost per case, but only about 1% of the variation in average cost per week.³⁹

Evans used the proportion of hospital business falling into each of 41 diagnostic and 40 age-sex categories as indications of case mix. These proportions, together with bed-size and occupancy-rate served as independent variables in cost equations with average cost per case and then average cost per day as dependent variables. These equations accounted for 90% of the variation between hospitals in average cost per case and about 10% of the inter-hospital variation in average cost per day. The diagnostic factors alone accounted for about 72% of the variation in cost per case and about 57% of the variation in cost per day.⁴⁰

Goodisman and Trompeter conclude from the research of M. Feldstein, Evans, and Berry that case mix is an important variable to consider in the examination of average cost per case and that raw case mix data is more useful in cost models than are surrogates of case mix. The research of all these authors is on the behavior of cost functions for many hospitals as they relate to different variables from a macro perspective. While their research indicates that case mix is a major factor in resource consumption and thus the cost of operations, they do not address the relationship of cost per case and case mix relative to one hospital's production function.⁴¹

Saartoff and Kurtz (1962) and later Cohen (1965) have studied cost in relation to output and point out the limitation of the patient day as a measure of output because of its inability to measure the severity of illness/case complexity relative to resource consumption and costs.⁴²

Judith R. Lave and Lester B. Lave's publication of "Hospital Cost Functions" in 1970 develops the concept of the hospital as a multi-product firm and the complexity of analyzing their cost functions because of this condition. This concept reinforced the need to limit the research to one principle product and to use a "composite output measure" or some measure of output mix. They develop the concept of the unique character of hospital cost functions due to the individuality of the component production functions. Recognizing the variation of interhospital output mix, they still propose that hospitals should have relative stability in their output mix over short periods of time (2-3 years).⁴³

Lave, Lave, and Silverman studied the cost functions including case mix variables and aggregation techniques to deal with multicollinearity using cross-section data for 65 hospitals. Regressing hospital characteristic variables and diagnostic mix variables versus average cost per case, their most significant finding pertinent to this research was that a high proportion of difficult cases raised costs and that a high proportion of common cases reduced costs.⁴⁴ This finding conceptually supports the fundamental question central to this research project.

Baron studied the behavior of average cost, marginal cost, obstetrics care, and obstetrics revenue with total cost used as the dependent variable and bed size plus input prices used as independent variables.⁴⁵

Martin Feldstein and James Schuttinger used multiple regression analysis to compare actual cost to the cost predicted on the basis of the hospital's case mix. (Case mix is defined as the proportion of patients falling into mutually exclusive case types.) They designed a measure of a hospital's costliness based on actual cost per case versus the cost per case predicted by the regression analysis.⁴⁶

Susan D. Horn and Phoebe D. Sharkey's research marks a refreshing departure from very macro oriented studies of cost. They have refined the study of resource consumption to a much finer focus. Examining health care delivery by diagnosis related group, they have related an estimate of resources consumed in the provision of care for a case (total charges) to an index for severity of illness, length of stay, laboratory charges, and routine charges for an individual patient. Most significantly, the

measurement of severity of illness's relationship to total charges by multiple regression analysis results in an adjusted coefficient of determination ($R^2 = 0.495$) and a $F=48.4$. The addition of a diagnosis related group variable to the prediction equation contributes nothing to the prediction equation's goodness of fit. This points to the importance of accounting for the variation of severity of illness within patient case groupings when studying the behavior of average cost per case.⁴⁷

The research of J. A. Rinaldo, D. J. McCubbrey, and J. R. Shyrock reinforces the work of Horn and Sharkey. They use medical diagnoses as product lines to study cost behavior. They define their product in a manner that Lave alluded to almost two decades earlier as being desirable: the patient is the product and the "basic unit of hospital output is a completed course of patient treatment consisting of all the medically significant services provided." Most notably, the effects of any differences in care are attributed to one of five causative factors: 1) physician practice, 2) patient condition, 3) patient volume, 4) patient mix, and 5) price.⁴⁸

Susan Horn reinforces the significance of severity of illness within a case mix category of illness. While Horn points out that "50% to 60% of the variation in charges within a diagnosis related group is explained by severity of illness," she also points out that "often the most severely ill patients use very few services, yet the severity level is high." Her research indicates that patients within a given case mix category can have very different resource use. The utility of the severity of

illness measurement is readily apparent when Horn drives home the point that "since severity of illness is attached to a case, it can be used with any grouping system."⁴⁹

Smith, Kahn, and Nesson's research into the cost of ambulatory care points to a potential flaw in cost research where charges are used to estimate cost, especially in the private hospital sector. Their research reminds one that third party cost reports provide the basis for reporting the locus of costs in hospital operations and thus influence charges that must produce revenues to cover these supposed expenses. Thus, the allocation of costs is driven by behavior focused on maximizing reimbursement mechanisms, not accounting for costs by actual cost center responsible. Smith, Kahn, and Nesson develop a method of cost allocation that assigns direct and indirect expenses to a cost center without the biases of third party reimbursement system cost reporting.⁵⁰

The Department of Defense Uniformed Chart of Accounts for Fixed Military Medical and Dental Treatment Facilities is a system ... "designed to record, accumulate, and report information regarding the expense (cost incurred) and workload (output) of specific and aggregate functions performed in military medical treatment facilities." DOD Regulation 6010.10 delineates how the Uniformed Chart of Accounts is structured to perform this task. Within this cost allocation system, expenses are assigned to responsibility centers and the output of each responsibility center is captured. The alignment of expense estimates with units of output permits one to estimate the weight or cost of output. "To determine the total cost of treating

a patient (either as an inpatient or outpatient), it is necessary to add all the expenses accumulated in the operating expense accounts..."⁵¹

Systems Model Design

Cowing, Holtman, and Powers summarize the last two decades of research in cost analysis and the models that have been tested for their relative value in portraying the behavior of varying aspects of hospital cost in the quote below:

A decade ago one of the brightest hopes for insight, and an area that everyone realized was critically important, was that of modeling hospital behavior. The hope was that new and alternative theories of hospital behavior might be developed, theories that would replace the older and largely inapplicable models based on profit maximization, and theories that would thereby permit the development of more suitable econometric models. But following a handful of early and pioneering efforts [Pauly and Redisch (1973), Newhouse (1970), Davis (1972)], there has been little further development in this area. Several recent studies [Harris (1977) probably provides the most useful discussion] have been helpful in suggesting directions for further work on this problem, but there is little conceptual consensus and virtually no econometric analyses.⁵²

They recognize the utility of the "neoclassical cost function:"

$$C = C(Q, p) = \sum_{i=1}^n x_i p_i$$

where C is minimal or cost-minimizing total cost; Q is output; x_i represents inputs; and p_i represents input prices. From this foundation they develop cost models that attempt to account for the behavior of long- and short-run cost structures and the multiple-output dimension of hospital services.

The Goodisman and Trumpeter publication concurs with that of Cowing, Holtman, and Powers on the lack of a single model of the hospital production process used in the analysis of hospital cost. They indicate that ambiguity

in defining a hospital's major product and identifying the consumers of that product has hindered the development of a clear model. Recommended is a model that would incorporate both process- and product-oriented measurements with conceptualization of a multi-phase production process where both the patient and the provider are consumers of the hospital's products.⁵³

Tatchell's research addresses the "fundamental approaches to defining and measuring hospital output found in the literature." The first involves final outcomes while the other involves intermediate outcomes. ..."In general, it is felt that output measures should reflect what is believed to be the ultimate objective of the health (and hospital) system--the improvement of health levels."⁵⁴

J. Lave's Review of the Methods Used to Study Hospital Cost reinforces the necessity for the model builder to understand the underlying cost structure of a hospital's departments and for the hospital as a unit to keep research conclusions relevant and justifiable.⁵⁵

Obstetric Delivery Systems

William's Obstetrics defines the terminology, delineates routine protocols for treatment, and fully develops the medical theory surrounding the general practice of obstetrics. Obstetrics is defined as "...the branch of medicine that deals with parturition, its antecedents, and its sequels. It is concerned principally, therefore, with the phenomena and management of pregnancy, labor, and the puerperium, in both normal and abnormal circumstances." "The transcendent objective of obstetrics is that every pregnancy be wanted and culminate in a healthy mother and a healthy baby."⁵⁶

The duration of a normal term of pregnancy (37-41 weeks) and its organization into three trimesters of thirteen weeks is developed conceptually by Pritchard and MacDonald. They also describe extensively the standards of practice for determining pregnancy, estimating the expected date of delivery, management and treatment during prenatal care, management and treatment during labor, and postpartum care.⁵⁷

Cannoodt develops the birthing center concept from the perspectives of the organizational structure (34% owned by corporations), provider characteristics (29.3% certified nurse midwife/physician), liability insurance, percentage of intrapartum transfers (13%), reimbursement mechanisms, and charges (47.7% of average hospital charges).⁵⁸

Lubic and Ernst's publication focuses upon the concept of childbearing centers and the principles for their operation:

"1. A childbearing center is an adaptation of the home, rather than a modification of the hospital.

"2. A childbearing center provides safe care to healthy families anticipating a normal childbirth experience.

"3. A childbearing center provides high quality maternity care at low cost.

"4. A childbearing center promotes family unity through participation of individual family members.

"5. Childbearing centers will prove to be effective primary care and referral services in regionalized perinatal care programs.

"6. Delineating the philosophy and nonclinical policies for a childbearing center are most effectively accomplished by a governing body

responsive to the idea of birth as a normal physiologic event.

"7. In order for a childbearing center to function effectively, both professionals and families must accept and respect each other's roles as members of a team.

"8. Education in preparation for childbirth, infant care, parenting, and general self-help is sine qua non of birth center operation.

"9. The successful operation of a childbearing center is based upon utilization of certified nurse-midwives, with expert physician consultation and a full range of supporting personnel and services."⁵⁹

RESEARCH METHODOLOGY

1. Conduct of a literature survey pertinent to:
 - a. CHAMPUS
 - b. Preferred provider organizations
 - c. Systems model design
 - d. Cost analysis
 - e. Obstetric delivery systems
2. Modeling the existing obstetrics services delivery system to identify the cost variables present.
 - a. Interview the Chief, OB/GYN, and the Chief, Family Practice per cost and procedures.
 - b. Interview the Head Nurse in Obstetrics and Labor and Delivery as above.
 - c. Interview the Comptroller as above.
 - d. Interview the Chief, Pharmacy as above.

- e. Interview the Chief, Radiology as above.
 - f. Interview the Chief, Pathology as above.
 - g. Use a pilot sample to review, analyze, and collect historical OB cost and case mix data per UCA charges and procedures. Sample the inpatient and outpatient treatment records of all November 1984 OB patients delivering at WACH per the terminal digit of their patient registration number on the quality assurance data base. List all reasonable cost factors in each record. Use Uniformed Chart of Accounts cost estimates to assign a cost to each factor possible and expert cost data to estimate the cost of other factors. Total the cost per case, estimate the population mean cost, and estimate the variance of the total cost data.
 - h. List all potential direct cost and ancillary cost variables in OB services, inpatient and outpatient.
 - i. Construct a systems model of the existing delivery system and list its cost variables (see Appendix A).
3. Determining the case mix composition (complexity and risk) of the WACH obstetrics population that is treated in house.
- a. Interview the Chief, OB/GYN and the nurse practitioner that conducts obstetrics registration for the risk and case complexity designation criteria specific to WACH. List these criteria for future record sampling procedures.
 - b. Use the seven months of active obstetric records kept in the OB/GYN clinic as a sample of the population provided obstetric services at WACH.

c. Identify the number of patient records designated as being of elevated risk or complexity and the reason for that designation.

d. Based on the sample above, estimate the percentage of the studied population that is of elevated risk or complexity and stratify these cases by medical condition criteria.

4. Determining the significant cost variables in predicting the cost of delivering obstetric services within the present delivery system.

a. Use the pilot sample data from step #2g to estimate the variance of the population studied, assist in sample size calculation, and delineate potential cost variables.

b. Based on the pilot sample, compute the minimum sample size necessary to achieve command acceptable error (d) as established subjectively after conversation with the Deputy Commander for Administration. The population size (N) about which estimates were to be made was 2,240 in 1984.

$$n = \frac{(z)^2 \cdot (s)^2}{(d)^2}$$

n = sample size
 z = test statistic ($\alpha = 0.10$)
 s = sample variance
 d = \$50.00

Randomly select the records of not less than ten obstetrics patients per cost variable considered while achieving a sample of at least minimum sample size as determined by the formula above. The sample is to be drawn without replacement from records of obstetrics patients treated for their entire term of pregnancy at WACH with delivery in calendar year 1984.

c. Given the model from step #2 and the pilot sample data to guide cost variable identification, delineate the cost variables in each patient's treatment records (see Appendix B). Use the UCA cost or input to assign cost to each variable in a patient's treatment

regimen and to compute the total cost of their obstetric services at WACH.

d. Use the all regression analysis method on the Infostat program (Burroughs) to identify the significant obstetrics cost variables (see Appendix C) and select the best regression equation retaining coefficients with significant t values at the $\alpha = 0.10$ level, achieving an overall variance ratio that is significant at $\alpha = 0.10$, and attaining a coefficient of determination of at least 0.70. Use a correlation matrix, the coefficient of determination, and variation in residual error to check the cost variables for collinearity.

e. Determine which cost variables are significant when predicting cost using a subjective combination of the regression analysis data per Daniel's text in biostatistics and the input from WACH operators of the organization specific model. Revise the tentative data collection form at Appendix B to accommodate the collection of cost data per the significant cost variables.

5. Determining the average cost per patient for obstetric services within the existing delivery system at WACH.

a. Ensuring that all significant cost variables identified in step #4 above have been captured in cost computations, sum the cost of obstetric services observed in the sample.

b. Divide the sum in step #5a by the sample size, n.

c. Obtain review and concurrence of the Comptroller.

6. Modeling the anticipated WACH obstetric service (post-CHAMPUS-PPO implementation) to identify the reasonably identifiable cost variables it would contain and the case mix composition of the population served.

a. Based on the literature research and the expert guidance of the C, OB/GYN; the Comptroller; the C, Patient Administration; and the Preceptor, construct a systems model of the anticipated WACH/CHAMPUS-PPO delivery system.

b. Consult the C, OB/GYN; the Comptroller; the C, Patient Administration; and the Preceptor to determine the WACH cost variables contained in the proposed WACH/CHAMPUS-PPO obstetrics service system and their relationships to total cost per obstetrics patient.

c. Model the case mix composition of the WACH/CHAMPUS-PPO obstetric system population based upon the systems model formed in step #6a above and the WACH-specific obstetrics population characteristics observed in step #3.

d. Confirm the accuracy of the systems model from step #6a and the associated cost variables with the Comptroller; the C, OB/GYN; and the Preceptor.

7. Determining the significant cost variables specific to the anticipated WACH obstetric service system (post-CHAMPUS-PPO implementation).

a. Extrapolate cost per variable in the WACH/CHAMPUS-PPO model wherever the variables are the same as identified in the existing system. For example, pharmaceutical and laboratory procedures may change in frequency but the cost per procedure is not likely to change in response to a change in the obstetrics delivery system. If a change in the basic procedures is found in the modeled system, obtain a literature estimate or expert input on the impact on cost per procedure.

b. Obtain from the literature or expert input the cost estimate data for variables unique to the WACH/CHAMPUS-PPO obstetrics system model. If a case mix change for WACH patients is part of the WACH/CHAMPUS-PPO system, the change in cost of services and their frequency must be estimated. The modeled WACH/CHAMPUS-PPO obstetrics patient population case composition (step #6c) and population characteristic data (step #3) will be used to construct a sample population from the same time period as the original system sample population.

Sample size will be calculated per the formula below:

$$n = \frac{(z)^2 \cdot (s)^2}{(d)^2}$$

This sample will be studied to capture the frequency of cost variables and the costs per obstetrics patient as in steps 4c through 4e above.

8. Determining the predicted average cost per patient for obstetric services within the WACH obstetric service system (post-CHAMPUS-PPO implementation) as a standard for average cost comparison.

a. Using the cost variables from step #6b, the cost per variable from step #7a and 7b, and the frequency of cost variables observed in the records of patients from the constructed sample (step #7b), compute the total cost estimate for obstetric services delivered within the modeled system's constructed sample. (See Appendix D)

b. Divide the total cost estimate above by the sample size (n) from step #7b to obtain the sample average cost (\bar{x}).

c. Obtain the Preceptor's and Comptroller's approval.

9. Determining if the average cost per patient of obstetric services delivered at WACH with traditional CHAMPUS referral systems will significantly increase after implementation of a CHAMPUS-PPO delivery system.

a. Use the average cost of existing obstetric services (\bar{X}_1) obtained at step #5b as an estimate of the population mean (μ_1).

b. Use the predicted average cost (\bar{X}_2 from step #8) for the obstetric services delivered at WACH after the CHAMPUS-PPO system is implemented as a standard of comparison for significant cost increase and an estimate of the mean of the population cost mean (μ_2).

c. Test $H_0 : \mu_1 \geq \mu_2$

$$\alpha = 0.10$$

$H_A : \mu_1 < \mu_2$

d. Plot the cost data on a histogram to estimate the character of its distribution.

e. Use a z, t, or other test (per the distribution) to test the hypothesis. Anticipated test is shown below:

$$z = \frac{(\bar{X}_1 - \bar{X}_2) - (\mu_1 - \mu_2)}{S_p \sqrt{1/n_1 + 1/n_2}}$$

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CHAPTER II

DISCUSSION

Pursuant to the literature survey summarized in the introduction, the initial step in the conduct of the actual research was to observe the operation of the obstetrics component of the health care delivery system at Womack Army Community Hospital (WACH). During this period of observation, multiple interviews were conducted with the principal parties in the elements of the obstetrics system:

OB/GYN CLINIC

Receptionist
Secretary
Nurse Practitioner/Head Nurse
Senior Noncommissioned Officer
Chief of OB/GYN

LABOR & DELIVERY

Head Nurse
Corpsmen

POSTPARTUM

Head Nurse

FAMILY PRACTICE

Chief

The information sought in these interviews was 1) what functions were performed by the parties interviewed and their specific sections, 2) how did their functions integrate into the overall obstetrics health care delivery system, and 3) how did they actually perform certain functions. Additionally, the parties were queried about 1) how they received the necessary resource inputs for the performance of their functions and what these resources cost, 2) the nature of the resource inputs used in the performance of their jobs, and 3) the nature of resources they used from other organizational elements of the hospital to accomplish their mission. The information

received from the above staff described the operations of the main health care delivery components of the Womack-specific obstetrics system and provided indications of the cost variables associated with the resources that made its operation possible. Observations of special significance to this research were:

1) Patients entering the obstetrics health care system did so by presenting themselves to the OB/GYN clinic with a positive pregnancy test or with any of a number of signs/symptoms that made pregnancy a very probable condition.¹ Active duty service members were immediately enrolled for treatment in the Womack system. Other eligible beneficiaries were enrolled after an initial quota, approximately 150, of expectant mothers was referred to CHAMPUS. Another 40 to 50 expectant mothers having the same expected month for delivery would be referred out to CHAMPUS as they risked out of the Womack obstetric system (see paragraph 3 below) or were determined to be beyond the volume capacity of the Womack system.

2) Once patients entered the obstetrics system at Womack, their treatment charts were maintained at the OB/GYN clinic and transferred to labor and delivery when the clinic was closed. The prenatal records (outpatient and inpatient) were then consolidated into the patients' inpatient charts after admission for delivery. Their outpatient charts contained misfiled pathology reports or records of treatment received during their pregnancy at other outpatient clinics.

3) Patients were evaluated for the potential risk of developing conditions that may endanger themselves or their babies during their initial

visits after pregnancy determination. If a patient was suspected to be of very high risk potential, she would be referred to an obstetrician by the nurse practitioner taking the initial history. Risk determination is a subjective decision based upon the individual patient's condition and history and is a decision made by the initial provider seen on that visit. A list of conditions and significant elements in a patient's history that predisposed a patient to being of elevated risk existed in the OB/GYN Clinic, but there was no formal risking out system. If the risk was sufficiently elevated (beyond the treatment capacity of Womack's obstetrical services or neonate services), the patient would be referred to CHAMPUS to minimize risk to the patient or newborn. If the risk of complications for an obstetrics patient or risk to the patient's baby became elevated during the course of prenatal care to a level beyond the treatment capacity of Womack, the same transfer out process would be followed until the patient delivered or was stabilized to a level of complexity/risk within Womack's capability. The number of patients transferred out of Womack due to the risk associated with their cases exceeding the capacity of the treatment system was 37 in 1984. The total number of patients referred to CHAMPUS for routine obstetrics care that exceeded the volume capacity of the providers and/or the newborn nursery in 1984 was 2162. The total number of patients delivered at Womack in 1984 was 1783.

4) Patients were scheduled for a continuum of prenatal obstetrics visits that were at one month intervals through the seventh month of pregnancy, at two week intervals in the eighth month, and at one week intervals

from the ninth month until delivery. During these visits, the patient was treated by the provider that happened to be in the clinic when the prenatal visit was scheduled; there was no attempt to have one provider follow a patient throughout an entire pregnancy. Instead, the philosophy was that the providers would become generally familiar with all cases so that whoever was on call when delivery occurred would be able to handle the case.

5) The protocol for the initial pathology work-up included a glucose, urinalysis, rubella titer, gonococcus screen, blood type, and blood cell count. This allows early identification of many of the diseases and conditions that can cause patients to be of elevated risk. These tests are repeated during the course of the pregnancy as necessitated by the condition of the mother and the baby.

6) The prenatal protocol included prenatal vitamins and ferrous sulfate tablets for almost every mother plus health, nutrition, and lifestyle education. Nutritional assistance was coordinated for families having financial difficulty.

7) Ultrasound was used to determine the size and to estimate the age/level of development of the baby. Its use was not a standard practice on every patient but was limited to those patients whose conditions warranted the diagnostic procedure.

8) Most patients delivered their babies in the delivery rooms in the labor and delivery suite. Repeat cesarean sections and emergency cesarean sections are delivered in the operating rooms to enhance sterile

conditions and anesthesia services. These patients recover in the surgical intensive care recovery room and then are transferred to the postpartum ward.

9) The standard postpartum ward stay for the mother is three days. The mean length of stay on the postpartum ward is 2.69 days as reported by the Patient Administration System and Biostatistics Activity.² The length of stay is determined by a number of factors including: a) the condition of the newborn, b) the condition of the mother (psychological and physical), c) the number of children that the mother has had before and the amount of parenting education required, d) the social support system awaiting the mother and baby, and e) the volume of patients on the postpartum ward. The standard for discharging a patient home is that the mother is capable of caring for both the baby and herself.

10) Four to six weeks after delivering, the mother was scheduled to return for a postpartum check-up.

11) The Womack obstetrics treatment system is in fact composed of two parallel systems, the main OB/GYN clinic system orchestrated by the obstetricians organic to Womack and the Family Practice system run by their providers as a segment of the continuum of care provided to the families they serve. The OB/GYN system delivers approximately 110 babies per month and the Family Practice system delivers approximately 37 babies per month. There were no significant differences observed in the conduct of care, the utilization of resources, the proportion of elevated risk patients treated, or the cost variables in the two systems.

Subsequent to the above observations and interviews, it was necessary to interview the head nurse of the newborn nursery. The standards of care set by the National College of Obstetricians and the American Academy of Pediatrics for the delivery of perinatal health care delineate very clearly the requirements for staff, physical plant, and technology in the newborn nursery.³ These standards limit the volume of babies that can be delivered at Womack and the acuity of the neonates that can be treated in Womack's level I nursery.

The Chief of Pharmacy, the Chief of Radiology, and the Chief of Pathology were interviewed. Information acquisition in these areas was limited to procedures performed to support the obstetrics delivery system and the associated cost variables. Finally, the Comptroller and Chief of the Uniformed Chart of Accounts section were interviewed to ascertain the level of cost detail that was practically available to describe the cost behavior of the Womack obstetrics system.

Using the terminal digit of the patient registration number and the international classification of disease codes for obstetrics admissions, a random sample of the obstetrics patients admitted to Womack in November 1984 was listed off of the automated quality assurance data base which contains patient care assessment information on all patients admitted in the last two years. From this listing, inpatient and outpatient charts were pulled and matched so that a complete audit trail of obstetrics care delivered to a patient could be traced in the record review. These charts were further limited to cases where the admission was for a delivery

performed at Womack so that a complete obstetrics course of treatment could be observed in the chart. A pilot sample of 32 charts was reviewed, analyzed, and used for the collection of historical obstetrics cost and case mix data.

The cost variables used as an initial basis for reviewing each chart were outpatient visits, special outpatient visits, number of inpatient days, special procedures including surgery, ultrasound, fetal monitor, non-labor and delivery procedures, and specialist requirements. These potential cost variables were collected on the form shown at Appendix B. Before actual review and analysis of the charts was initiated, the use of a fetal monitor was deleted as a variable because of its inclusion in the routine labor and delivery treatment protocol that was incorporated into inpatient cost for treatment in labor and delivery. The detailed pharmaceutical and pathology cost information was collected because of its documentation in the charts and the ability to separate these costs from daily inpatient and outpatient costs in the UCA step down process. The cost variables selected for study parallel those utilized by Susan D. Horn and Phoebe D. Sharkey's research into the impact of severity of illness upon the cost of delivering health care.⁴ The assumption that the indirect cost of delivering obstetric services at Womack will not change significantly due to a CHAMPUS-PPO delivery system change allows the research to focus upon direct costs that are more apparent in the observation of an operational treatment system and have more meaning to the people working in the system.

The patient's risk of developing complications was assessed from the notes made by the nurse practitioner and the obstetrician during the initial obstetrics history and physical found in the Standard Form 533 (Medical Record of Prenatal and Pregnancy) and on the Standard Form 509 (Doctor's Progress Notes). The number of outpatient visits could be determined by counting the separate accounts of outpatient visits in the outpatient chart's Standard Form 600 (Chronological Record of Medical Care) and the inpatient chart's Standard Form 509 plus the Standard Form 533. The number of inpatient days associated with a course of obstetrics treatment was determined by summing the number of days per obstetrics admission per pregnancy per patient found on Department of the Army Form 3647 (Inpatient Treatment Record Cover Sheet). Reports of radiological procedures found on Standard Form 588 were used to ascertain the number of ultrasound procedures performed. Reports of pathology procedures were used to determine the number of lab procedures performed by their general type (urinalysis, blood cell counts, blood typing, herpes screen, gonococcus screen, glucose, chemistries, etc.). The pharmaceuticals used in the prenatal and perinatal treatment of a patient were determined from notes made on the Department of the Army Form 4677 (Therapeutic Documentation Care Plan), the Standard Form 533, the Standard Form 509s, the Standard Form 534 (Labor Medical Record), and the Standard Form 539 (Abbreviated Medical Record). Very rarely, pharmaceuticals prescribed for patients treated outside of the OB/GYN clinic during the course of their pregnancy could be found in their outpatient charts on the Standard Form 600.

Based upon the assumption that the data collected by the Uniformed Chart of Accounts since 1982 is accurate, the estimation of cost associated with each variable was achieved through the use of data found in the Uniformed Chart of Accounts financial management information system. This system allocates direct and indirect costs of operations in a step down fashion to responsibility centers and refines these to shield the centers from being "charged" with costs not associated with the performance of their mission. The allocation of costs is based on a proration of expenses; personnel expenses are allocated by time spent in an area or function and non-personnel expenses are allocated by work load performed. The cost per clinic visit and inpatient days for obstetrics patients was computed by stepping down all direct and indirect expenses to the four digit responsibility center code for these areas.

To avoid duplication of costs and achieve more detail in cost data, the pathology, radiology, and pharmacy expenses were "backed out" of (not stepped down to) the OB/GYN clinic and perinatal responsibility centers. All other personnel, materiel, administration, and depreciation expenses were stepped down to the responsibility centers. Using the unit cost and the Uniformed Chart of Accounts procedural weight, the estimated costs of laboratory procedures, ultrasound, and pharmacy procedures were calculated. Surgical costs are based on time in the operating room, anesthesia, and recovery. To estimate the cost of a cesarean section, the time for each of these areas was taken randomly from the operating room log for 32 cesarean sections performed in 1984 and the mean time for each component of the procedure was calculated (operating room = 0.95 hours, recovery room =

1.13 hours, and anesthesia = 1.72 hours). The weighted cost of each component of a surgical procedure was then multiplied by its observed mean time to derive its estimated cost and then summed to estimate the cost per cesarean section. The cost of patient administration's preparation and maintenance of inpatient and outpatient charts was included in the cost per day of inpatient care and in the cost per outpatient clinic visit. The estimated cost per variable used to analyze the total cost of delivering obstetrical care documented in each chart is shown at Appendix E.

Given the cost variables of interest, the estimates of cost per variable, and the records selected for the pilot sample, the calculation of the total cost per case was a simple math exercise founded upon the "neoclassical cost function" concept that the cost of delivering health care was the summation of the cost variables (inputs) multiplied by the cost of each input (price).⁵ Estimation of the population mean cost (μ) was performed by summing the total cost per case and dividing by the size of the pilot sample.⁶

$$\bar{x} = \frac{\sum_{i=1}^n x_i}{n}$$

where x_i = the total cost per case

n = the size of the pilot sample

The variance of the pilot sample is calculated to estimate the dispersion of the population of total cost per obstetrics case about the mean cost per case.⁷ This calculation is performed by applying the following formula:

$$\text{variance } (s^2) = \frac{\sum_{i=1}^n (x - x_i)^2}{n-1}$$

where x_i = the total cost per case

\bar{x} = the mean cost per case

n = the sample size

The observations of the total cost per case are at Figure 2-1. The pilot sample estimates of the mean cost per case and variance are shown at Figure 2-2.

1) 735.45	9) 1079.99	17) 1935.30	25) 1041.94
2) 1260.76	10) 942.13	18) 778.30	26) 712.55
3) 548.95	11) 1463.30	19) 942.90	27) 942.90
4) 1222.71	12) 1054.20	20) 769.43	28) 1989.35
5) 1133.85	13) 1119.13	21) 1086.65	29) 1300.81
6) 453.32	14) 999.68	22) 1287.78	30) 1054.72
7) 870.49	15) 1810.48	23) 703.02	31) 1567.55
8) 840.61	16) 1796.25	24) 1884.67	32) 1446.18

FIGURE 2-1. OBSERVATIONS OF TOTAL COST

a) Sample Size:

$$n = \frac{(Z)^2 \cdot (S)^2}{d^2}$$

b) Variance (s^2): $s^2 = \frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n-1}$

Where $Z = 1.28$ at $\alpha = 0.10$ per hypothesis stated on page 32.

$$s^2 = 167523.19$$

$$d = \$50.00$$

$$\bar{x} = 1148.69$$

Then sample size (n) is

$$n = \frac{(1.28)^2 \cdot (167523.19)}{2500} = 109.79 \text{ or } 110$$

FIGURE 2-2. FORMULA AND CALCULATIONS OF SAMPLE SIZE BASED ON PILOT SAMPLE ESTIMATES ON THE POPULATION CHARACTERISTIC s^2 (VARIANCE)

Based on the information gathered in the process above, a model of the obstetrics systems with annotated cost variable input by source was prepared and staffed through the following principal parties: 1) Chief, OB/GYN, 2) Chief, Family Practice, 3) Head Nurses of OB/GYN and Labor and Delivery, 4) Comptroller, 5) Chief of Pharmacy, 6) Chief of Radiology, 7) Chief of Pathology, and 8) Chief of Patient Administration. All parties reviewed the model for accuracy in its design, relationships, logical representation of the obstetrics system, and the cost variables it contained. The final cost model of the WACH obstetrics system derived from the above process with all reasonably identifiable cost variables listed is shown at Appendix F.

Determining Case Mix Composition

Interviews with the Chief of OB/GYN, the Chief of Family Practice, and the Nurse Practitioner/Head Nurse of the OB/GYN clinic indicated that while no formal system existed for risking out patients, there was a common set of medical conditions and patient history criteria that predisposed patients for obstetrician determination of risk/complexity. These criteria are summarized in Figure 2-3 on page 49.

The medical records of seven months of active obstetrics cases kept in the OB/GYN clinic were analyzed as a sample of the population of obstetric patients treated at WACH. The sample consisted of 627 medical records. The medical records of patients having been identified as being of elevated risk or complexity were marked on the outside so providers would be alerted during further treatment. There were 57 medical records (9.09%) of the 627 records in the sample so marked. The risk/complexity criterion or criteria underlying this decision for the patients in the sample are stratified by the frequency of occurrence in the sample at Figure 2-4 on page 50.

1) Sociodemographic

40 years of age and over without previous birth
45 years of age and over having previous births
illiteracy/language barriers

2) Maternal Medical History

chronic hypertension
heart disease
renal disease
current mental health problem
epilepsy or seizures
drug addiction
diabetes mellitus
bleeding disorder and/or hemolytic disease
previous Rh sensitization
five or more previous births
three or more spontaneous abortions
previous cesarean section
herpes
gonococcus
syphilis
history of preeclampsia
incompetent cervix
multiple gestation
cervical cerclage
asthma
placenta previa

3) Maternal Physical Findings

obesity
inadequate pelvis

FIGURE 2-3. WOMACK CRITERIA FOR OBSTETRIC CASE
RISK/COMPLEXITY

<u>CRITERIA</u>	<u>FREQUENCY</u>
Previous cesarean sections	22 (0.0351)
Herpes	5 (0.0080)
Cervical cerclage	4 (0.0064)
Diabetes	3 (0.0048)
Placenta Previa	3 (0.0048)
Asthma and placenta previa	2 (0.0032)
Multi-gestation	2 (0.0032)
History of premature complications	2 (0.0032)
Gonorrhea	2 (0.0032)
Femoral artery stenosis	1 (0.0016)
History of genetic fetal problems	1 (0.0016)
Seizure disorders	1 (0.0016)
Syphilis	1 (0.0016)
History of spontaneous abortions	1 (0.0016)
Incompetent cervix	1 (0.0016)
Maternal age and multi-gestation	1 (0.0016)
History of epilepsy	1 (0.0016)
Rh negative blood type	1 (0.0016)
Multi-gestation and Rh negative blood type	1 (0.0016)
Illiteracy, obesity, and multiple pregnancies	1 (0.0016)
History of stillbirths and hydrocephalia	1 (0.0016)

FIGURE 2-4. OBSERVED RISK CRITERIA STRATIFIED
BY FREQUENCY

Determining the Significant Cost Variables.

In predicting the cost of delivering obstetric services within the existing delivery system, determination of the statistical significance of the cost variables was important to the complete evaluation of the behavior of cost within the system. If a healthy mother, discharged home and capable of caring for her healthy newborn child and herself, is the theoretical product of the obstetrics health care delivery system at Womack, then the treatment system can be analyzed economically as a multi-product line with a series of resource inputs and optional transformation processes tailored to the needs and desires of the patient to achieve that outcome.⁸

Rinaldo, McCubbrey, and Shyroch using the product line concept to study cost behavior, concluded that variations in care are attributable to price, patient volume, physician practice, patient condition, and patient mix.⁹ Limiting the population studied to obstetrics admissions resulting in a delivery keeps the case mix variation focused on a set of patient conditions and severity of illness within a treatment group and thus makes the variation of care provided to a patient more manageable for study. Susan Horn reinforces the significance of severity of illness within a case-mix category by pointing out that 50% to 60% of the variation in charges within a diagnosis related group is explained by severity of illness.¹⁰ The risk variable was studied for its behavior in the analysis of obstetrics cost because of the practical question at hand. What would happen to the average cost of obstetrics care if a change in the treatment system resulted in a change in the case mix or severity of illness of patients?

Based on observation of the pilot sample, the literature review, and practical considerations of cost data availability, the first six cost variables listed below were selected for use in examining each inpatient and outpatient medical record and used to estimate the total cost of delivering obstetric care for each patient. All cost variables listed below were selected for use in analyzing the behavior of the cost variables in the population studied--obstetrics patients admitted and delivering at WACH in 1984:

- 1) days of inpatient care
- 2) outpatient clinic visits

- 3) pathology procedures performed
- 4) radiology procedures performed
- 5) pharmacy procedures performed
- 6) surgery performed
- 7) routine versus high risk/case complexity

In calculating the sample size to be used for studying the behavior of cost in the population of interest, estimates of the behavior of cost in the population derived from the pilot sample were necessary. The variance of the total cost of delivering obstetrics services to the cases studied in the pilot sample was 167,523. The mean cost of delivering obstetrics services to the same cases was \$1148.69. Using a 0.10 level of significance, the z value equals 1.28. A range (d) of acceptable error in total cost estimates was established at \$50.00. From this information, the minimal sample size necessary to study the cost behavior in the population of interest was calculated to be equal to 110 cases. This is based on the formula and calculations at Figure 2-2.

A random sample of the charts of obstetrics patients admitted and delivering at WACH in 1984 was listed off of the quality assurance data base by use of the terminal digit of the patient registration number and international classification of disease codes. These charts were verified to meet the population parameters by quick observation of the patient discharge summary and used for the study when both the inpatient and out-patient medical records could be assimilated. Of an initial listing of 169 potential cases for study, 119 met all of the parameters. Concerns

about statistical outliers diminishing sample size if they should be eliminated during the eventual regression analysis led to the study of all 119.

The impact of patients transferring into and out of the obstetric population studied led to the assumption that the number of obstetric patients departing the Womack treatment system prior to completion of services equals the number arriving from other posts. From this assumption, one can proceed to study the cost behavior observed in each patient's chart without trying to account for care that may have been delivered by WACH to a patient that eventually delivers elsewhere. This concern was also minimized by population design--focusing upon patients that were admitted and delivered at WACH permitted the observation of an entire course of pregnancy.

Experience from the cost audit of the pilot sample led to revision of the form used to record the information extracted from each record set. This new form (see Appendix G) delineates the cost variables of interest in a manner that allows observations to be recorded in a minimum amount of time. Using this new form, the 119 sets of medical records were analyzed for their content and frequency of cost variables. Observations of cost variables were made in the same manner as discussed on page 44.

The outliers in the basic data set of 119 observations were considered from both pure statistical and practical perspectives. Observations of total cost more than two standard deviations (\$450) from the mean (\$1130) were considered statistical outliers. These total cost outliers (\$2727, \$2554, \$2360, \$2224, \$2159, and \$2026) were considered for elimination from the sample but this seemed opposed to observing the behavior of the

Womack-specific obstetrics health care delivery system and the total cost outliers were left in the data set. Patients failing to enter the treatment system until their last six to eight weeks of pregnancy (or later) can hardly be expected to reflect the ability of the treatment system to evaluate the risk level of a pregnant patient and the efficacy of the treatment system when this is normally done in the first trimester. It was expected that leaving these behavioral outliers in the sample could contribute variation in cost behavior to the study that could detract from the ability to observe meaningful relationships between cost variable behavior and the risk assessment variable. However, the fourteen behavioral outliers and their observation sets were a significant portion of the population studied as well as a reality of obstetrics health care at Womack. For this reason, they were also left in the sample.

To further study the cost behavior of the selected variables in the population of obstetrics patients admitted and delivering at Womack in 1984, the "Infostats" software was used in conjunction with the Burroughs hardware organic to the hospital.¹¹ To evaluate the distribution character of the selected cost variables, frequency polygons were plotted (see Figure 2-5, a-f). The frequency distribution of inpatient days, total cost, pharmacy procedures, and pathology procedures resembled robust F-distributions. This was not surprising when total cost of health care delivery and the utilization of pharmaceuticals and pathology procedures in obstetrics is dominated by length of stay like so many other treatment regimens. The frequency polygon for the ultrasound cost variable, an outpatient

procedure, also resembled an F-distribution. The frequency polygon for outpatient visits was shaped like an F-distribution in reverse. This is not surprising when viewed in relation to the overall treatment system where a patient enters the prenatal care regimen for a fixed period of potential treatment time before delivery and obtains prenatal care on visits in accordance with her behavior, history, and condition. The frequency polygons were designed using Sturges Rule and considerations of practical utility as guidelines.¹²

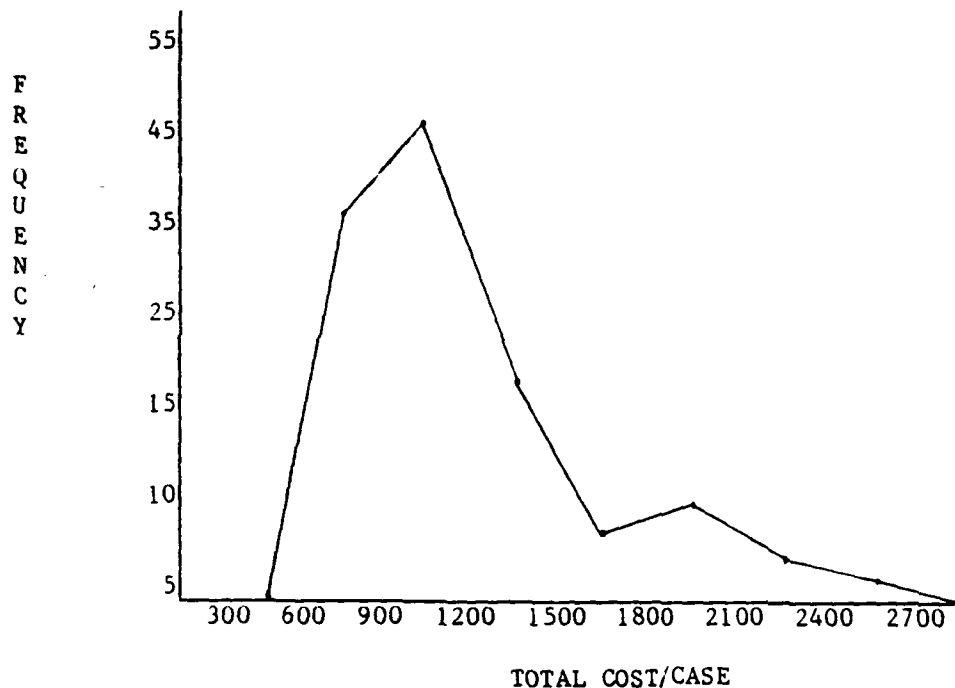


FIGURE 2-5-A. "TOTAL" VARIABLE FREQUENCY POLYGON

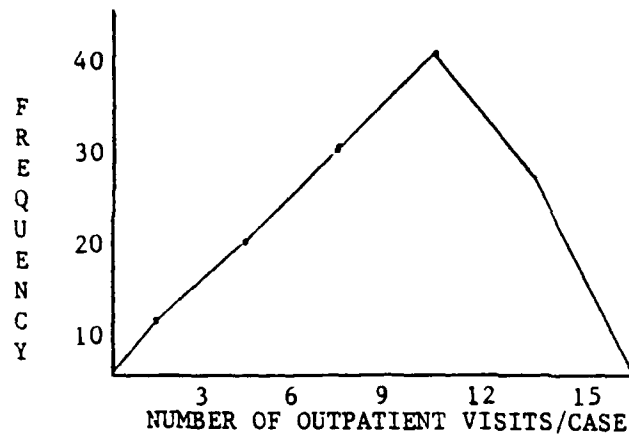


FIGURE 2-5-B. "OUTPT" VARIABLE FREQUENCY POLYGON

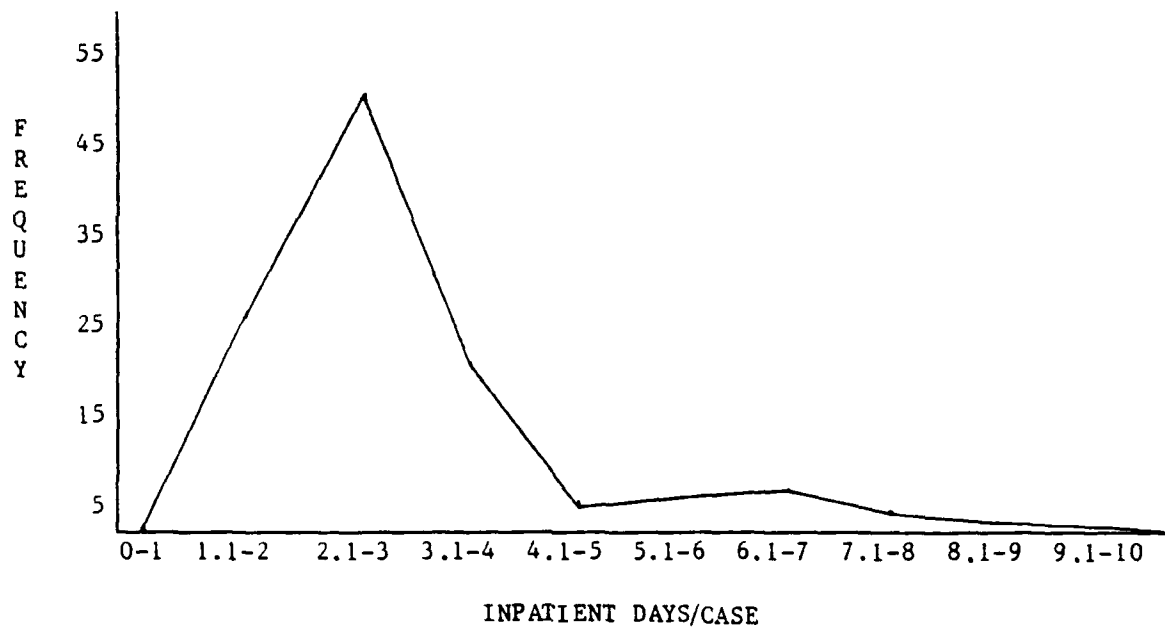


FIGURE 2-5-C. "DAYS" VARIABLE FREQUENCY POLYGON

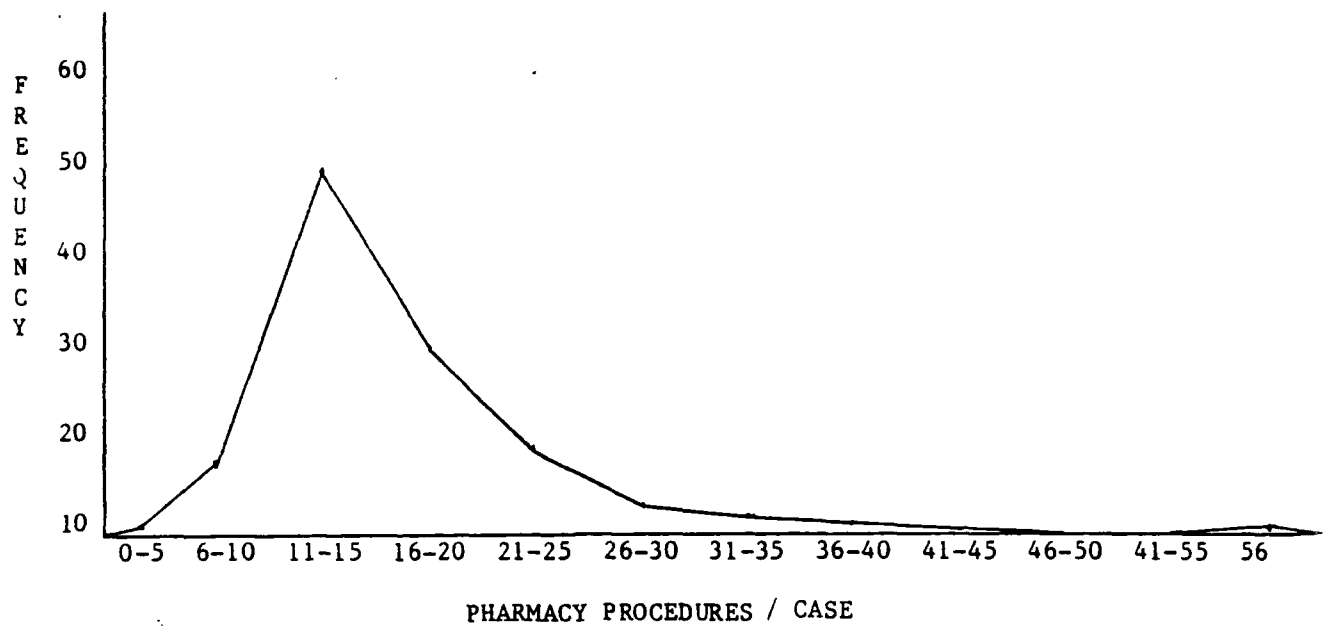


FIGURE 2-5-D. "PHARMACY" VARIABLE FREQUENCY POLYGON

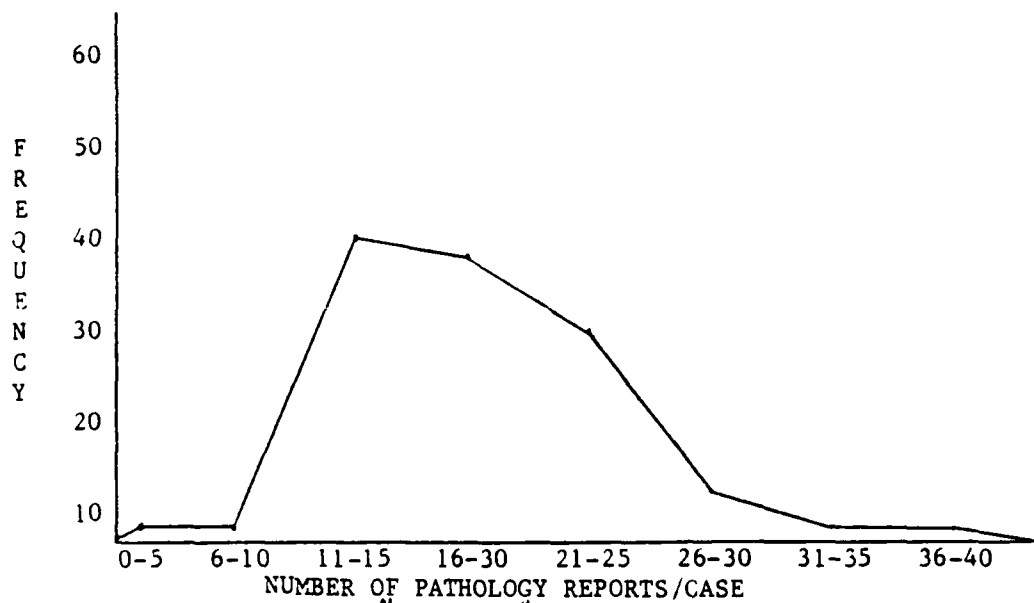


FIGURE 2-5-E. "PATHOLOGY" VARIABLE FREQUENCY POLYGON

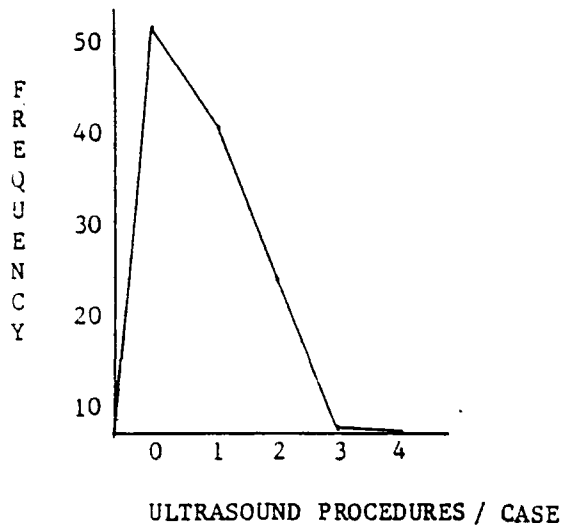


FIGURE 2-5-F. "US" VARIABLE FREQUENCY POLYGON

To evaluate the strength of the relationships of the cost variables with each other and total cost, a correlation matrix was run to show the Pearson's correlation coefficient, student t-value of the correlation coefficient, and the probability of the relationship (measured by the correlation coefficient) occurring spuriously (see Figure 2-6). This information serves two functions for this study. First, it provides indications of multicollinearity between cost variables. Secondly, it provides indications of which variables will be significantly useful in regression against total cost.

PEARSON CORRELATION ANALYSIS

Variables Correlated

- (1) RISK (Risk dummy variable per observed risk level determination)
- (2) TOTAL (Total cost observed per patient)
- (3) OUTPT (Outpatient visits per patient)
- (4) US (Ultrasound procedures per patient)
- (5) PIARH (Pharmacy procedures per patient)
- (6) DAYS (Inpatient days per patient)
- (7) SURG (Dummy variable for presence or absence of Cesarean Section)
- (8) PATH (Pathology procedures per patient)

	RISK	TOTAL	OUTPT	US	PIARH	DAYS	SURG	PATH
RISK	1.000000 (119) T=4.90 S=0.000000	0.412940 (119) T=4.90 S=0.000000	-0.151191 (119) T=-1.65 S=0.100727	0.301500 (119) T=3.42 S=0.000862	0.236682 (119) T=2.63 S=0.009555	0.426140 (119) T=5.10 S=0.000000	0.248763 (119) T=2.78 S=0.006371	0.365151 (119) T=4.38 S=0.000000
TOTAL	0.412940 (119) T=4.90 S=0.000000	1.000000 (119) T=4.90 S=0.000000	0.225203 (119) T=2.50 S=0.011798	0.337056 (119) T=3.87 S=0.00178	0.591571 (119) T=8.06 S=0.000000	0.967892 (119) T=41.65 S=0.000000	0.616845 (119) T=8.93 S=0.000000	0.652287 (119) T=9.31 S=0.000000
OUTPT	-0.151191 (119) T=-1.65 S=0.100727	0.225203 (119) T=2.50 S=0.011798	1.000000 (119) T=4.90 S=0.000000	0.115247 (119) T=1.25 S=0.211997	0.020601 (119) T=0.22 S=0.82401	0.042962 (119) T=0.47 S=0.642701	0.162781 (119) T=1.78 S=0.076926	0.285771 (119) T=3.23 S=0.001630
US	0.301500 (119) T=3.42 S=0.000862	0.337056 (119) T=3.87 S=0.00178	0.115247 (119) T=1.25 S=0.211997	1.000000 (119) T=4.90 S=0.000000	0.161964 (119) T=1.78 S=0.078440	0.235006 (119) T=2.85 S=0.003129	0.089174 (119) T=0.97 S=0.334811	0.323529 (119) T=1.70 S=0.000332
PIARH	0.236682 (119) T=2.63 S=0.009555	0.591571 (119) T=8.06 S=0.000000	0.020601 (119) T=0.22 S=0.82401	0.161964 (119) T=1.78 S=0.078440	1.000000 (119) T=4.90 S=0.000000	0.577355 (119) T=7.65 S=0.000000	0.380330 (119) T=4.45 S=0.000000	0.367871 (119) T=4.01 S=0.000107
DAYS	0.426140 (119) T=5.10 S=0.000000	0.967892 (119) T=41.65 S=0.000000	0.042962 (119) T=0.47 S=0.642701	0.235006 (119) T=2.85 S=0.003129	0.577355 (119) T=7.65 S=0.000000	1.000000 (119) T=4.90 S=0.000000	0.520238 (119) T=6.59 S=0.000000	0.553123 (119) T=7.18 S=0.000000
SURG	0.248763 (119) T=2.78 S=0.006371	0.616845 (119) T=8.93 S=0.000000	0.162781 (119) T=1.78 S=0.076926	0.089174 (119) T=0.97 S=0.334811	0.380330 (119) T=4.45 S=0.000000	0.520238 (119) T=6.59 S=0.000000	1.000000 (119) T=4.90 S=0.000000	0.491307 (119) T=6.10 S=0.000000
PATH	0.365151 (119) T=4.38 S=0.000000	0.652287 (119) T=9.31 S=0.000000	0.285771 (119) T=3.23 S=0.001630	0.323529 (119) T=1.70 S=0.000332	0.367871 (119) T=4.01 S=0.000107	0.553123 (119) T=7.18 S=0.000000	0.491307 (119) T=6.10 S=0.000000	1.000000 (119) T=4.90 S=0.000000

FIGURE 2-6. PEARSON CORRELATION ANALYSIS MATRIX

Engaging first the consideration of multicollinearity, the relationship of inpatient days to surgery, pathology procedures, and pharmacy procedures is noteworthy ($r=0.52$, 0.55 , and 0.58 respectively) suggesting the potential for the violation of the base line assumption of independence of the variables regressed against the dependent variable. The pathology cost variable was also significantly related to surgery with a correlation coefficient equal to 0.49 . The ultrasound cost variable is statistically significant in its relationships with risk, days, and pathology. These variables were considered for combination with each other as an ancillary support cost variable or for elimination in their use in the regression of total cost in order to increase the utility of the regression equation product by decreasing the potential cost of its future use. The lack of practical utility of a composite Pharmacy/Pathology variable was also a concern. This decision was reserved until observation of the behavior of the cost variables as a total set in the regression analysis.

The correlation matrix was indicative of the strength of relationships to be expected between total cost of obstetrics care delivery and the cost variables selected for analysis as a total set. The t -values of the correlation coefficients indicated that all of the cost variables were significantly related to total cost. However, the correlation coefficients themselves were low enough for the risk, outpatient, and ultrasound cost variables that their practical significance was questionable. All of the cost variables were retained for the initial run of the regression analysis.

Prior to performing any multiple regression analysis upon the observed data, the assumptions underlying this analytical process were reviewed. In multiple regression, the relationship between the dependent variable (total cost) and the independent or explanatory variables is assumed to be linear.

While this assumption was intuitively acceptable because of the character of the cost variables within the observed treatment system, a final check was made by analyzing the residual error associated with the most parsimonious regression equation selected below. This analysis revealed no pattern that would contradict the assumption of linearity and is plotted at Figure 2-7. The independent variables are non-random (fixed) variables. Concern arises when assuming that for each set of independent values there is a subpopulation of dependent variable values that are normally distributed. The frequency polygon for total cost is robustly F-distribution in character causing one to anticipate that the subpopulation of Y values for each set of independent variable values may also vary from the normal distribution. However, as Daniel's text points out, it is rare that all assumptions surrounding regression analysis are met perfectly. It is noteworthy that in Daniel's text, he teaches multiple regression with length of stay variables. Furthermore, multiple regression is the analytical technique used most frequently in the literature to study the cost of health care delivery. The robust character of the distribution of total cost makes it approximate a normal distribution sufficiently for this study. The assumptions of equality of subpopulations of the dependent variable values and their independence are acceptable.

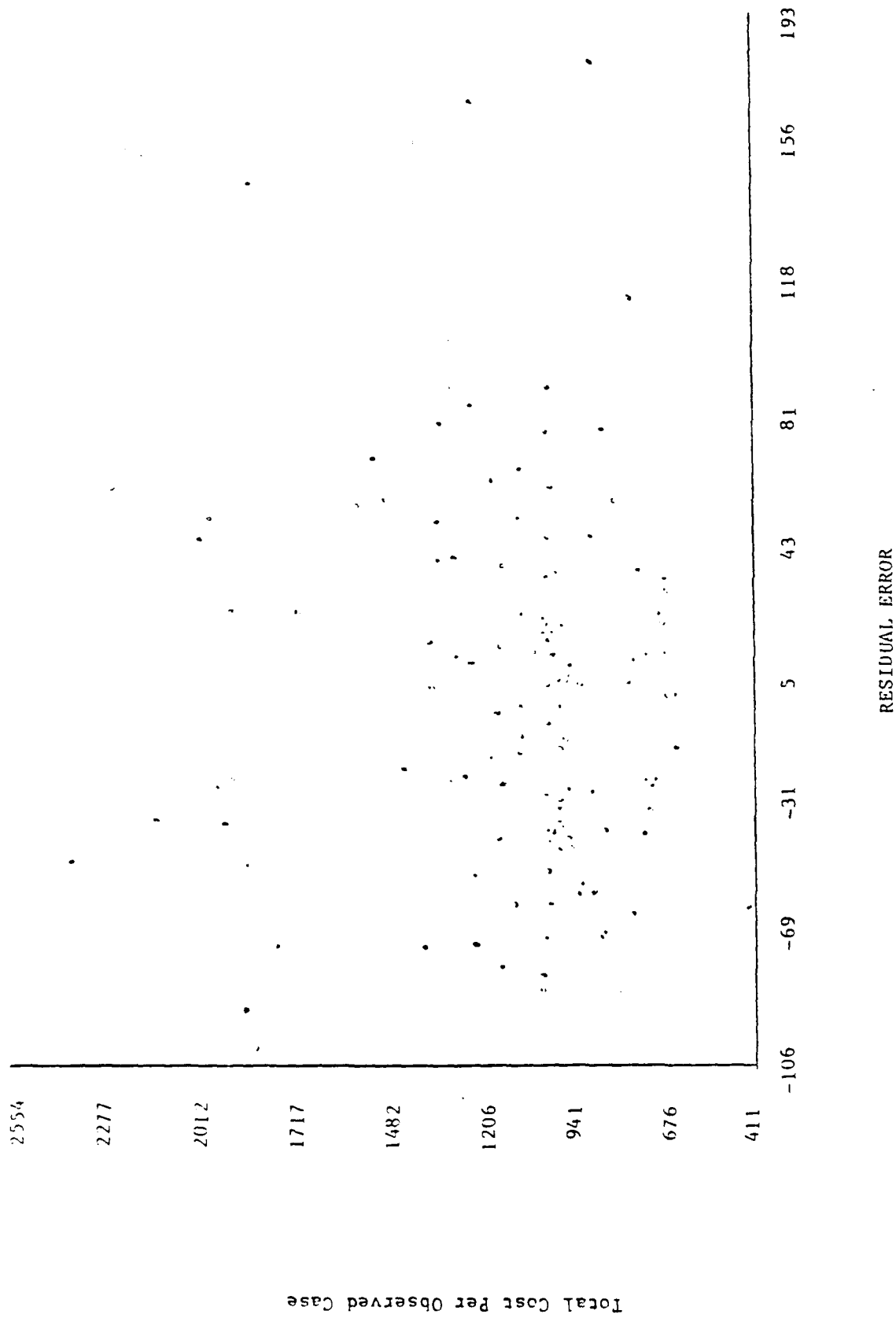


FIGURE 2-7. Total Cost vs Residual Error

The Burroughs "Infostats" software has an "All Regression" function that will run a regression analysis of all possible subsets of the independent variables on the dependent variable and print out the best five prediction equations per selected criteria. To ascertain how the cost variables behaved when regressed as a set against total cost, an "All regression" multiple regression analysis of all possible subsets of cost variable combinations was run on the Burroughs computer system. The criterion for selection of the overall best regression equation was the best significant coefficient of determination (r^2). The system tolerance was set at 0.10 to align it with the selected level of significance ($\alpha = 0.10$). The five best combinations of the independent variables were observed and the overall best prediction equation produced given these parameters was:

$$\text{TOTAL} = -2.9(\text{RISK}) + 16.0(\text{OUTPT}) + 44.0(\text{US}) + 2.3(\text{PHARM}) + 228.0(\text{DAYS}) + 195.4(\text{SURG}) + 3.9(\text{PATH}) - 193.3$$

TOTAL is the variable for the observed total cost of delivering obstetrics care per patient. RISK is the dummy variable used to represent the presence or absence of patient potential risk per the obstetricians and nurse practitioners notes in the chart; the numeral one was used for absence of risk and the numeral two was used for the presence of risk. OUTPT is the variable representing the frequency of outpatient visits made to the hospital during the course of prenatal care per patient. US is the variable for the frequency of ultrasound procedures in a patient's treatment regimen. The PHARM variable represents the number of pharmacy procedures per patient. DAYS is the number of inpatient days observed in a patient's chart for the entire course of the pregnancy. SURG is the dummy variable indicating the absence or presence of a cesarean section; the numeral one was used for the absence of the procedure and the numeral two was used if the procedure was present. PATH is the variable for the number of pathology procedures per patient.

The value of the regression criterion (r^2) exceeded the standard established in the research methodology (0.70) equalling 0.996. The t-values for the partial coefficients of the variables were:

<u>Cost Variables</u>	<u>t-Values</u>
1) RISK	-0.383
2) OUTPT	15.012
3) US	12.726
4) PHARM	5.617
5) DAYS	91.268
6) SURG	19.157
7) PATH	6.258

The only variable lacking a significant t-value at the 0.10 level of significance for its regression equation coefficient was RISK. The variance ratio, F, for the regression equation was equal to 3539.2 where:

$$F = \frac{\text{mean squared error explained by the regression equation}}{\text{mean squared error not explained by the regression equation}}$$

With seven (7) degrees of freedom in the numerator and one hundred-eleven (111) degrees of freedom in the denominator and using the 0.10 level of significance, the critical F-value of 1.82 from Daniel's text is far exceeded.¹³

Prior to eliminating the RISK variable as lacking statistical significance in a regression equation that appears to be extremely powerful in its ability to predict the total cost of obstetric care for a patient, the question of masking the cost behavior of one or more variables through the interaction or multicollinearity of other variables must be addressed. This is done by using a stepwise regression analysis which holds combinations of variables constant while entering additional variables one at a time. This allows the observation of the behavior of the cost variables as they enter the regression equation. Throughout this procedure, the criterion for entering a variable set on the computer is the F-value from Table J of Daniel's text with the level of significance ($\alpha=0.10$). The changes in degrees of freedom in the numerator and denominator matching the number of variables entered into the regression equation were adjusted in each step. When the table of F-values did not offer a degrees of freedom value

that matched exactly with the regression equation, the F-value was selected from the more rigorous of the available values. The tolerance was maintained at 0.10 to match the selected level of significance.

As each new combination of regression variables was formed, a correlation matrix was run allowing one to observe the correlation coefficients for the partial regression coefficients change with each new combination. This also was indicative of the multicollinearity of the variables as well as the strength of intervariate relationships.

The first variable entered into the regression equation was DAYS. DAYS was selected because of the strength of its statistical relationship with total cost based on the Pearson's correlation coefficient matrix discussed above. The coefficient of determination (r^2) achieved from this regression equation was 0.945 with a variance ratio equal to 1780.6 and residual (unexplained) error equal to 1034964.

The SURG variable was entered into the regression equation next, retaining DAYS in the regression equation based again on the correlation matrix. The coefficient of determination (r^2) achieved using these two variables regressed against total cost of delivering obstetrics care per patient was 0.972 with a variance ratio of 1786.5 and residual error equal to 525323. The gains in the coefficient of determination and the decrease in the residual error resulting from the entry of the SURG variable were noteworthy.

The PATH variable was entered while retaining SURG and DAYS in the regression equation because of its correlation with total cost. The gain in the coefficient of determination ($r^2 = 0.977$) was minor while the residual error fell to 432242. The changes in degrees of freedom associated with

adding an additional variable resulted in a slight decline in the variance ratio (F-ratio = 1440.5).

Considering the student t-value of the US variable coefficient in the all subsets regression equation and the correlation matrix, the US (ultrasound) variable was entered into the regression equation next. This resulted in a minor increase in the coefficient of determination ($r^2=0.984$), a significant decline in residual error, and a gain in the variance ratio.

Using the same composite indicators for variable entry as used with US, the outpatient (OUTPT) variable was entered. The result was a noteworthy increase in the coefficient of determination ($r^2=0.994$), a substantial decline in the residual error to 98100, and a 260% increase in the variance ratio to 3800.

The addition of the PHARM variable to the regression equation had only minor effects on the coefficient of determination ($r^2=0.996$), the residual error (73951), and the variance ratio (4164). An attempt to enter the RISK variable failed because it failed the F-value criterion for entry. The computer print outs of the stepwise regression are sequentially displayed as discussed above at Appendix H.

Having observed the all possible subsets regression for the best regression equation, the stepwise inclusion of the cost variables into the regression equation, and the impact of these approaches upon the criteria for selection of the most parsimonious combination of all factors, the final step in the process was to eliminate variables that carried the risk of collinearity. Of utmost importance to the research question

is the potential masking of a significant regression contribution by the risk variable through violation of the assumption that the variables be independent. To eliminate those variables, correlation matrixes were used to identify variables having statistically strong relationships with each other. Retaining DAYS and OUTPT because of their dominance in the regression of total cost and independence in correlation matrix and distribution polygons, they were regressed along with RISK using all possible subsets regression against total cost. This set of variables minimizes the potential for multicollinearity to the DAYS-RISK relationship that had a correlation coefficient of 0.426 in the all cost variables correlation matrix. The coefficient of determination ($r^2=0.971$), the variance ratio (1304.5), and student t-values of the coefficients (t-value ≥ 2.16) of the variables retained in the regression equation are acceptable by criteria established in the research methodology (step 4d, page 29). The amount of residual error retained in the regression equation after minimizing multicollinearity potential is much greater than when the cost variables were all retained but the potential contribution of the risk variable is no longer masked by the interrelationships of the other variables. To prevent the error of disregarding a variable that is in fact statistically significant when cost variables interrelationships are minimized, the risk variable should be retained in the regression equation.

The practical significance of the above is that in collecting cost data in the future and predicting the behavior of cost and risk variables, it would be better not to back out pharmacy, pathology, and ultrasound costs because of their strong intervariate relationships. Instead, it would be an improvement to use inpatient days and outpatient visits to regress or predict total cost of delivering obstetrical care with ancillary costs stepped down into the respective inpatient and outpatient responsibility centers. The surgical cost variable needs to be retained in the calculation of total cost because surgery is a responsibility center to itself and these costs would not be captured if this cost variable was ignored. It may not need to be retained in the regression equation for total cost to achieve goodness of fit if the DAYS and OUTPT variables behave the same way once ancillary costs are stepped down into them. This would minimize the organizational cost of future independent variable observation/ collection while enabling the prediction of total cost of obstetric care.

Examination of the all possible subsets regression of DAYS, OUTPT, and RISK variables produces the most parsimonious solution accounting for all of the criteria and not erroneously overlooking the RISK variable. A summary of the regression data surrounding this set of cost variables is at Figure 2-8. Most noteworthy are the coefficients associated with the cost variables and their t-values, the coefficient of determination ($r^2 = 0.971$), and the residual error (682,940).

Dependent Variable

TOTAL

Independent Variable

DAYS; RISK; OUTPT

Observation Range: 1-119

Multiple R = 0.985623

R-Squared = 0.971453

Analysis of Variance

	Sums of Squares	Degrees of Freedom	Mean Squares	F-Ratio
Regression	---	3	7746738.000	1304.469
Residual	682940.700	115	5938.615	
Total	---	118		

Variables Entered in Equation

Variable(s)	Coefficient	Std Error	F-to-Remove	T-Value
Constant	-75.3637			
Days	260.0955	4.8421	2885.4000	53.7159
Risk	41.5541	19.2559	4.6569	2.1580
Outpt	24.2739	1.9876	149.1549	12.2129

FIGURE 2-8. SUMMARY DATA OF THE TOTAL COST REGRESSION USING DAYS, RISK, AND OUTPT VARIABLES

While the RISK variable may be statistically significant, the practical significance of the variable is questionable. Holding the contributions of all of the other variables constant, the dummy variable for RISK only contributes \$41.55 to the total cost regression of a routine patient and \$83.10 to the total cost regression of a high risk patient. With a mean cost exceeding a thousand dollars described below, this is a very minor cost variable.

Reflecting upon the works of Susan Horn which purported 50% of the variation of charges to severity of illness within diagnosis related group

specific case mix, this is initially surprising. However, when taken in the context of the variables used to collect cost data and to regress the total cost, it is not surprising at all. First, the variable DAYS is the dominant cost variable by virtue of the many types of expenses that are stepped down into it; DAYS accounts for 71% of the total cost of an average patient's cost for obstetrics care. While the frequency of resource consumption and the cost attributable to this variable can be observed with the given research methodology and cost data that is practicably available, the intensity of the services provided within that day cannot be accounted for in a retrospective study. The averaging impact of the Uniformed Chart of Accounts weighted cost methodology has an averaging influence upon the assignment of cost that makes product line application of its cost very challenging. The leveling effect of using UCA cost may still be preferable to basing cost analysis upon charges that are skewed by reimbursement systems.

The observation captured by the RISK variable must also be kept in mind when contemplating the practical significance of its behavior in the regression equation for total cost.

Unlike a severity of illness index, the determination of risk is indicative of potential for case acuity or complexity, not its absolute presence. Successful prenatal treatment, responsible patient behavior, or pure chance may minimize the risk or complexity of a case that is initially screened to be of elevated risk.

A correlation matrix was run for the final regression equation of TOTAL using DAYS, OUTPT, and RISK. When these variables are isolated as a set for observation of their relationships, the strength of the relationship between inpatient days and risk becomes visible. If the objective of studying the cost behavior of the cost variables was not to see how case risk/complexity influenced the total cost of delivering health care to this group of patients and was for purely economic prediction of total cost per patient, then the next step would be to eliminate the risk variable from the regression equation because of its violation of the assumption of independence. The Pearson correlation analysis matrix at Figure 2-9 displays the intervariate relationships.

The data collection form at Appendix G was revised to capture only inpatient days, outpatient visits, the presence of surgery, and the risk determination of the patient's case as shown at Appendix I.

PEARSON CORRELATION ANALYSIS

- (1) Total
- (2) Days
- (3) Risk
- (4) Outpt

	Total	Days	Risk	Outpt
Total	1.000000 (119) T = *** S = 0.000000	0.966656 (119) T = 40.83 S = 0.000000	0.412940 (119) T = 4.90 S = 0.000000	0.225203 (119) T = 2.50 S = 0.012798
Days	0.966656 (119) T = 40.83 S = 0.000000	1.000000 (119) T = *** S = 0.000000	0.428725 (119) T = 5.13 S = 0.000000	0.37174 (119) T = 0.40 S = 0.688145

	Total	Days	Risk	Outpt
Risk	0.412940 (119) T = 4.90 S = 0.000000	0.428725 (119) T = 5.13 S = 0.000000	1.000000 (119) T = *** S = 0.000000	-0.151191 (119) T = -1.65 S = 0.100727
Outpt	0.225203 (119) T = 2.50 S = 0.013798	0.37174 (119) T = 0.40 S = 0.688145	-0.151191 (119) T = -1.65 S = 100727	1.000000 (119) T = *** S = 0.000000

FIGURE 2-9. PEARSON'S CORRELATION ANALYSIS MATRIX OF TOTAL, DAYS, RISK, AND OUTPT VARIABLES

Determining the Average Cost Per Patient

Including all of the costs identified per case in the methodology discussed above, the costs in the total sample of 119 observations of obstetric patients were used to calculate the total cost of delivering care to the population sampled. The outpatient visit outliers were included in this calculation because even if their behavior during prenatal care is systematically illogical, they remain a fact of every day operations in the delivery of health care. The total cost was divided by the sample size to produce the sample's estimate of the population mean cost of delivering care to those obstetrical patients admitted and delivering at Womack. The mean cost was \$1130.37 with a standard error of \$41.27. This cost was reviewed and concurred with by the Comptroller who is the organization's proponent for financial management.

Modelling the Anticipated WACH Obstetric Service

Anticipating the entry of a CHAMPUS endorsed preferred provider organization into the operational environment of the Womack Army Community Hospital, the obstetrics health care delivery system was modelled to structure the potential operational system and to facilitate the study of changes that would have a cost impact upon the WACH delivery system.

Presentations by representatives of Highsmith Rainey Hospital indicated that obstetric services could be provided to the patients delivering at their birthing center for \$1400.00 including physician and birthing center fees; this represents \$1400.00 in CHAMPUS savings per patient electing to use this form of obstetrics services. The major concern of this study is whether the implementation of a CHAMPUS-PPO obstetrics health care delivery system would change the average cost of delivering obstetrics services to the segment of the population served at WACH.

The potential for this to occur lies predominantly in the systematic risking out of pregnant patients to ensure that only low risk obstetrical patients are finally delivered in the birthing center. This is an absolute requirement for birthing center operations because of their decreased capital investment in technology to deal with perinatal emergencies that are statistically low in probability using their screening system for patient input. A sample of such a system is at Appendix J.¹⁴ Perusing the far more stringent risk criteria used by this type of facility, one should remember that patients are risked out of this system throughout their pregnancy as their treatment progresses and risks are identified. If the population of patients retained for treatment at WACH is changed to maximize the number of low risk (therefore eligible) patients referred to CHAMPUS and the PPO operation, the acuity/risk of the patients retained for treatment may be elevated and increase the average cost of delivering obstetric services. If patients risked out of the CHAMPUS-PPO birthing center are allowed to be referred back to WACH for treatment, the same potential exists.

Interview of the Chief of OB/GYN and his key staff confirmed their resolve not to provide obstetric services to patients they were not going to eventually deliver because of overwhelming volume of existing prenatal care demands. The only patients to receive prenatal risk determination and the history/physical associated with this process and then be referred out to a CHAMPUS provider were those that were found to exceed the treatment capability for the Womack obstetrics treatment system due to risk to the mother or child. The acceptance of patients presenting for emergency delivery without prior prenatal care at WACH is a fact of doing business for any hospital having an obstetrics service. The referral of patients sent to CHAMPUS back to the WACH system would continuously disrupt the planning for patient flow through labor and delivery, newborn nursery operations, and provider availability. Two of the baseline assumptions for this research were that manpower and facility resources at Womack would not change as a result of or during a CHAMPUS-PPO delivery system change, nor would the demand for obstetric care at WACH change. Thus, the referral of patients previously sent to a CHAMPUS provider back into the WACH system is considered to be intolerable and if the patient is of elevated risk beyond the treatment capability of WACH, it would result in a further CHAMPUS referral to a facility that has the ability to deal with cases of elevated risk. The PPO contending for entry into the Fayetteville marketplace plans to transfer emergency patients to Cape Fear Valley Medical Center, another hospital in the city of Fayetteville, which has a complete range of obstetrics services and a neonatal intensive care capability.

Once a patient is referred out to a CHAMPUS provider, the decision of facility for delivery is a patient-provider joint decision. Return to Womack for delivery is an economically poor decision for the provider. Thus, the risk composition of the obstetrics case mix of patients treated at WACH is not seen as changing due to any external change in the CHAMPUS system. This minimizes the potential for change in the average cost per case in the area of case mix specific or product line cost behavior elaborately analyzed by Judith Lave.

The volume of patients treated in the WACH obstetrics system is driven by internal provider availability and newborn nursery standards of care that limit the volume of newborns to be treated in the hospital's nursery at any time. The Womack system is going to maximize the utilization of its own delivery system prior to the referral of patients out to a CHAMPUS provider. Therefore, changes in the external delivery system are not considered to have the ability to modify the volume of patients treated in the WACH system and drive up the fixed costs per patient that were so significant in the cost analyses of Feldstein.

The legal consideration of elevated cost due to potential malpractice claims against the Army secondary to referral to a CHAMPUS-PPO birthing center is minimized by leaving the selection of provider up to the patient after referral out to CHAMPUS. The subsequent selection of the PPO birthing center would be a decision made by the patient and provider independent of any alleged coercion by the WACH treatment system or its CHAMPUS advisors. The procedures for referral of patients to external treatment systems

after nonavailability of internal services and subsequent assistance/counseling on claims preparation remains unchanged in anticipated structure and volume.

Given these considerations, a model of the proposed Womack Army Community Hospital obstetrics delivery system after the implementation of a CHAMPUS-PPO birthing center was designed and staffed by the Chief of OB/GYN and his staff, the Comptroller, the Chief of Patient Administration, and the Deputy Commander for Administration (Preceptor). The consensus of these parties after review of the model was that no changes in the WACH treatment system would occur as a result of the implementation of the CHAMPUS-PPO birthing center. The only economic changes anticipated in the obstetrics treatment system for the area at large were totally externalized. The content of the reasonably identifiable cost variables was ascertained for this model as for the model of the WACH system before CHAMPUS-PPO implementation. Consultation with the same parties confirmed that the relationships of these cost variables to the total cost per obstetrics patient remained unchanged.

The modelled case mix composition of the obstetrics population treated at WACH after implementation of the CHAMPUS-PPO birthing center is based upon the sample of 627 treatment records taken in the OB/GYN clinic in research methodology step 3. The absence of change in the patient input or risking out procedures resulted in the case mix model being stratified with population proportions exactly aligned with those observed in the population prior to the CHAMPUS-PPO change. This model is shown at Figure 2-4.

Confirmation of the Womack obstetrics systems model (post-CHAMPUS-PPO implementation) and the associated cost variables was made with the Comptroller, the Chief of OB/GYN, and the Deputy Commander for Administration (Preceptor) to gain their interdisciplinary expertise.

Determining the Significant Post-CHAMPUS-PPO Implementation Cost Variables

The absence of change in the anticipated Womack Army Hospital obstetrics treatment system after implementation of the CHAMPUS-PPO birthing center keeps the cost variables practical for study the same in the existing and anticipated models of the treatment system. The estimates of cost per variable remain unchanged. The volume and case mix of the population of interest remains unchanged as does the severity of illness associated with the mix of patients in the population. This makes the sample taken of the existing obstetrics treatment system representative of the population and treatment system after implementation of the CHAMPUS-PPO birthing center. Further sampling of the population and analysis of cost within the population is redundant.

Determining the Predicted Average Cost Per Patient After CHAMPUS-PPO Implementation

The predicted average cost per obstetrics patient admitted and delivering at Womack Army Community Hospital after the implementation of the CHAMPUS-PPO birthing center is the same as observed in the existing treatment system. The frequency per cost variable remains unchanged as does the cost per variable. Thus, the average cost stability was confirmed with the Comptroller and the Deputy Commander for Administration (Preceptor).

Determination of Significant Increase in Average Cost Per Patient

Without change in the existing and anticipated treatment systems, populations treated, volume of patients, or case mix of patients, the anticipated average cost per delivery in the WACH obstetric treatment system is equivalent to the average cost per delivery observed in the existing system. The application of statistical analysis to test the null hypothesis that the average cost of the existing treatment system is greater than or equal to the anticipated system's average cost per patient is superfluous when the estimated costs are equal. If the average costs are equal, then the null hypothesis must be accepted at any level of significance.

$$H_0 : \mu_1 \geq \mu_2$$

$$H_A : \mu_1 < \mu_2$$

The answer to the research question can be determined without any further testing, for if the average costs are equal, then it cannot be concluded that the average cost of delivering obstetrical service at WACH would increase significantly after the implementation of a CHAMPUS-PPO delivery system.

FOOTNOTES

¹Jack A. Pritchard & Paul C. McDonald, Williams' Obstetrics, (New York: Appleton Century-Crofts, 1980): 261-265.

²Patient Administration System and Biostatistics Activity, "Length of Stay Data for Deliveries, Fort Bragg and Like MTF FY83," (Fort Sam Houston, TX, 1984)

³American Academy of Pediatrics & American College of Obstetricians and Gynecologists, Guidelines for Perinatal Care, (Washington DC: AAP & ACOG, 1983): 15-46.

⁴Susan D. Horn & Phoebe D. Sharkey, "Measuring Severity of Illness to Predict Patient Resource Use Within DRGs," Inquiry (Winter 1983): 314-321.

⁵T. G. Cowing, A.G. Haltman, & S. Powers, "Hospital Cost Analysis: A Survey and Evaluation of Recent Studies," Advances in Health Economics and Health Services Research 4(1983); 257-283.

⁶Wayne W. Daniel, Biostatistics: A Foundation for Analysis in the Health Services (New York : John Wiley & Sons, 1983): 17.

⁷Ibid., p. 21

⁸Judith R. Lave, "A Review of the Methods Used to Study Hospital Costs," Inquiry 3 (2) (May 1966): 57-81.

⁹J. A. Renaldo, D. J. McCubrey, and J. R. Shyrock, "The Care-Monitoring, Cost-Forecasting, and Cost-Monitoring System," Journal of Medical Systems 6 (3) (1982): 315-327.

¹⁰Susan D. Horn, "Does Severity of Illness Make a Difference in Prospective Payment?," Healthcare Financial Management, (May 1983): 49-53.

¹¹Burroughs Corporation, Interactive Forecasting and Statistical Analysis Systems Statistics (INFOSTATS/STATISTICS) (Detroit: Burroughs Corporation, 1978): 3-1A.

¹²Daniel, Biostatistics: A Foundation for Analysis in the Health Sciences, p. 7.

¹³Ibid., p. 504.

¹⁴Ruth W. Lubic, Evaluation of an Out-of Hospital Maternity Center for Low Risk Patients, (New York: McGraw-Hill Book Co., 1980): 1-28.

CHAPTER III

CONCLUSION AND RECOMMENDATION

It cannot be concluded that the implementation of a CHAMPUS-PPO delivery system would significantly increase the cost per patient of obstetric services at Womack Army Community Hospital. Observation and modelling of the existing obstetric system for juxtaposition with the systems model of the anticipated Womack obstetric system post-implementation of the CHAMPUS-PPO birthing center demonstrated that WACH would be able to externalize the change in its operational environment. Even if this had not been the case, the lack of practical significance of the risk variable sheds doubt upon the potential for alteration of the WACH obstetrics case mix enough to significantly impact upon the cost of delivering obstetric care.

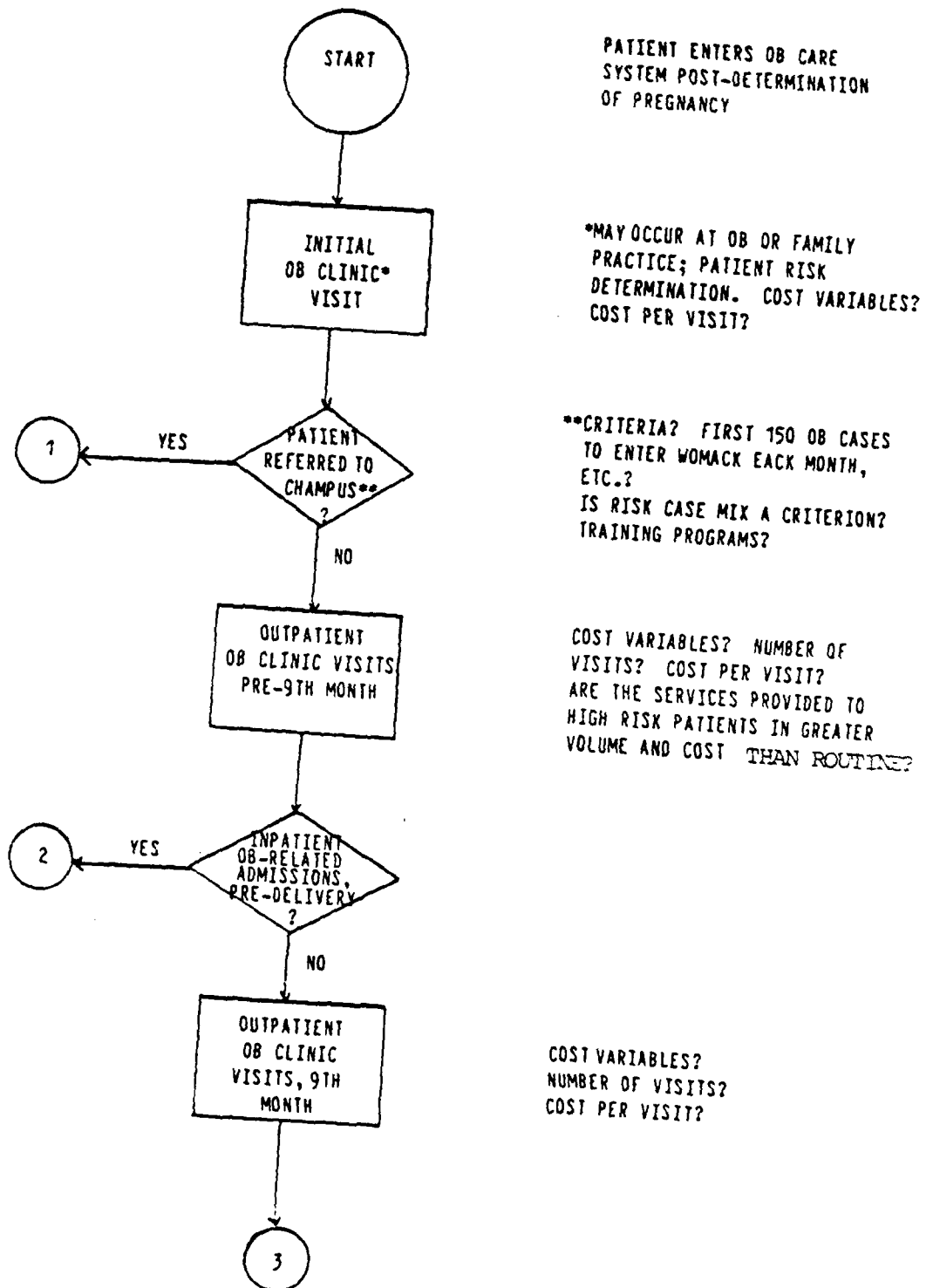
These observations and the above conclusion are specific to Womack Army Community Hospital alone. The production functions, operational constraints, and population characteristics found at this facility cannot be generalized to other facilities that may have a newborn nursery with level II and III capabilities, more obstetricians and supporting staff, and different physical plant operational considerations. The product line approach to cost analysis using the cost estimates from the Uniformed Chart of Accounts and multiple regression analysis has utility for the study of cost behavior in obstetrics and other health care service areas within any Army Medical Department treatment facility.

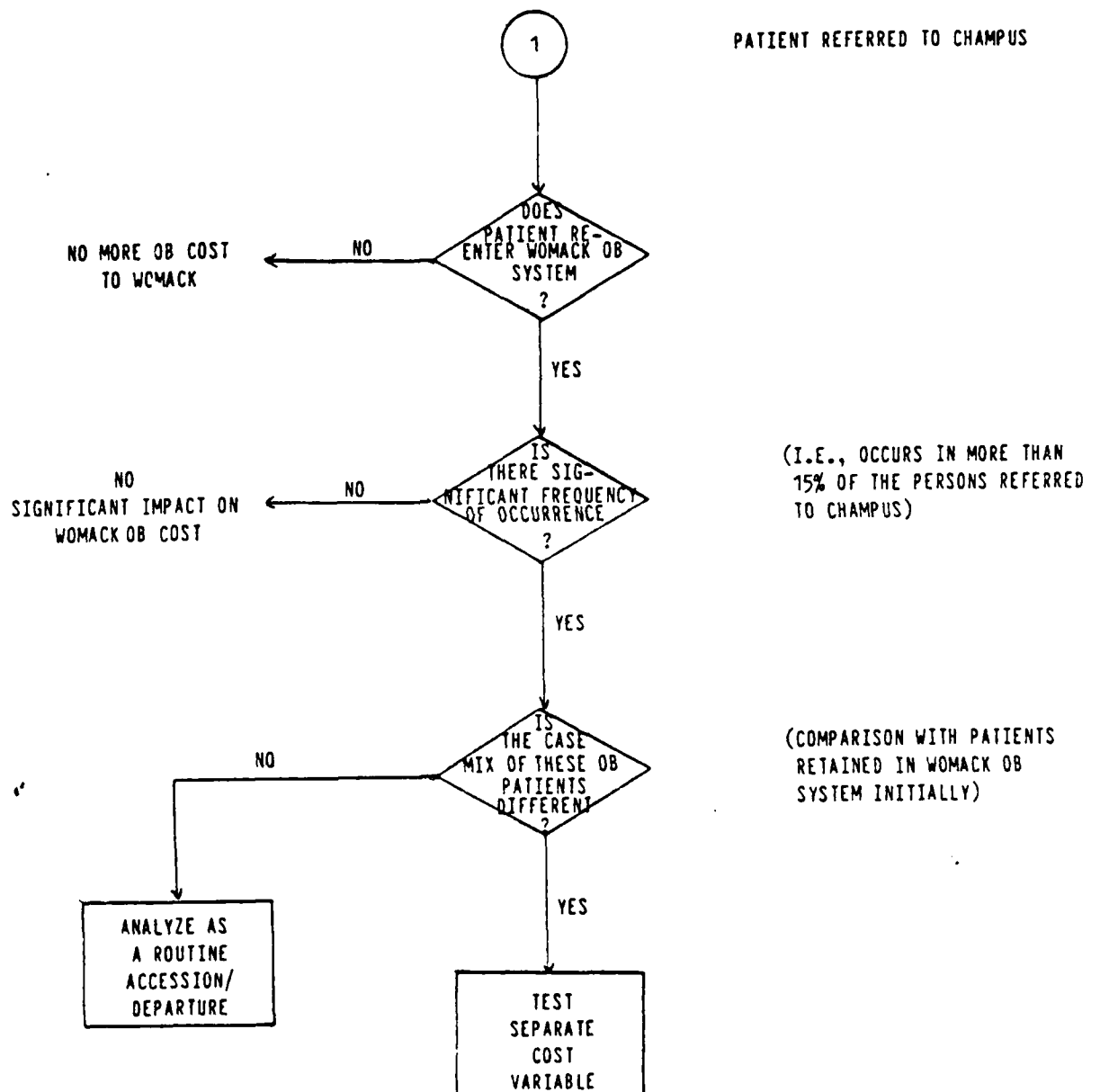
Based upon this research, it is recommended that WACH proceed with actions supporting the CHAMPUS-PPO birthing center initiative. It is recommended that further study of the cost behavior in this area use the treatment of the mother and the child until discharge of both as a single product. While this will increase the complexity and scope of the transformation processes that must be studied, it may better reflect the success or failure of the treatment process and the cost associated with the process.

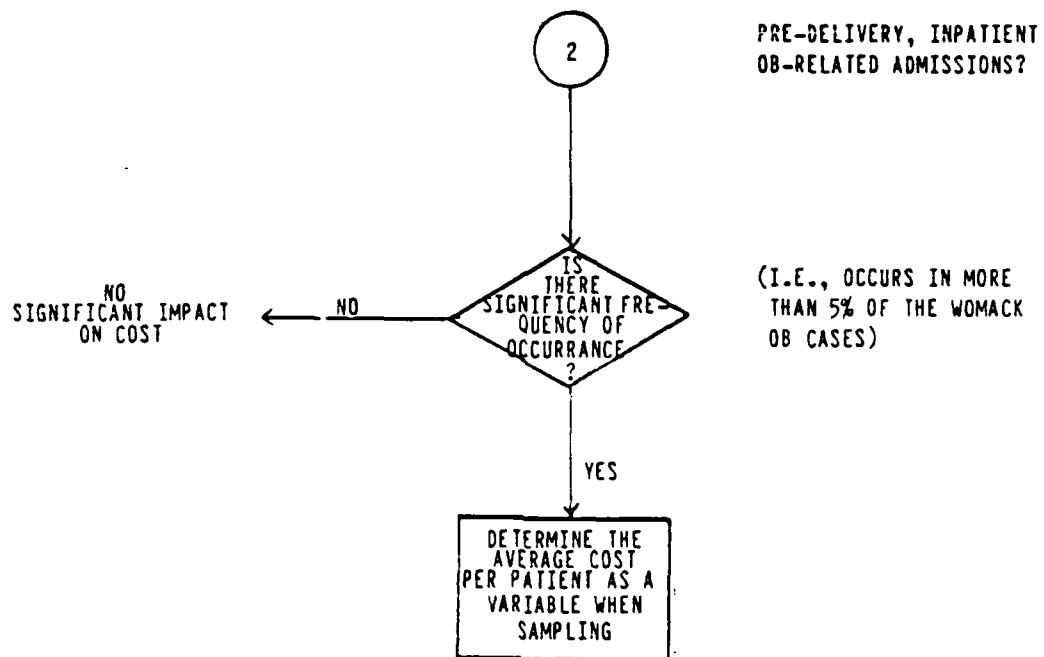
APPENDIX A

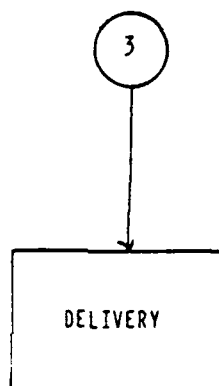
PROPOSED DUMMY MODEL FOR EXISTING
OB SERVICES AT WOMACK

APPENDIX A
 PROPOSED
 DUMMY MODEL FOR EXISTING OB SERVICES AT WOMACK









TYPE OF DELIVERY?
NUMBER OF DAYS AS
OB INPATIENT PRE-
AND POST-PARTUM?
SPECIAL PROCEDURES?

APPENDIX B

PROPOSED TYPE OF DATA COLLECTED IN RECORD
SCREEN OF SAMPLE RECORDS

APPENDIX B

PROPOSED
TYPE OF DATA COLLECTED IN RECORD SCREEN OF SAMPLE RECORDS

1. Record # _____
2. Type Patient (1st Trimester Screen)
 High Risk? _____ Why _____
 Routine? _____
3. Number of outpatient visits? _____ Cost* _____
4. Special outpatient procedures? _____ Cost _____
5. Number of inpatient days associated with obstetrics condition? _____ Cost _____
6. Special Procedures?
 - a. Surgery? _____ Cost _____
 - b. Ultrasound? _____ Cost _____
 - c. Fetal monitor? _____ Cost _____
 - d. Other (specify) _____ Cost _____
 - e. Non-labor and delivery procedure? _____ Cost _____
 - f. Specialist requirement? _____ Cost _____

* Per UCA

APPENDIX C

PROPOSED DUMMY MATHEMATICAL MODEL #1

APPENDIX C

PROPOSED
DUMMY MATHEMATICAL MODEL #1

Y_1 = Cost of OB services per patient given the existing CHAMPUS referral system.

X_1 = Observed number of OB outpatient visits per patient in FY84 sample.

B_1 = Estimated cost per OB outpatient visit per patient in FY84 sample.

X_2 = Observed number of OB related inpatient days per patient in FY84 sample.

B_2 = Estimated cost per OB related inpatient days per patient in FY84 sample.

X_3 = Case mix (risk level) of each OB patient retained for treatment at WACH.

B_3 = Estimated cost per the risk level of the patient.

X_4 = Observed number of special procedures for OB patient care per patient (visits or consults).

B_4 = Estimated cost of special procedures per patient per case risk.

$$Y = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 + \dots + B_nX_n.$$

APPENDIX D

PROPOSED METHOD FOR CONSTRUCTION OF COST MODEL
AFTER CHAMPUS-PPO REFERRAL SYSTEM IS IMPLEMENTED

APPENDIX D

PROPOSED METHOD FOR CONSTRUCTION OF COST MODEL AFTER CHAMPUS-PPO REFERRAL SYSTEM IS IMPLEMENTED

Y_2 = Cost of OB services at Womack given a modeled CHAMPUS-PPO referral system.

X_1 = Number of OB outpatient visits per time frame (FY84) per patient.

B_1 = Cost of an OB outpatient visit per time frame (FY84).

X_2 = Number of OB inpatient days per patient.

B_2 = Cost of an OB inpatient day per patient

X_3 = Case mix (risk level) of each OB patient retained by WACH (dummy variable).

X_4 = Cost of special procedures per case risk.

X_5 = Cost of "risk out" cases returned to WACH.

B_5 = Number of "risk out" cases returned to WACH.

$Y_2 = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 + . . . B_nX_n.$

NOTE: To compute the above costs and associated frequencies of occurrence, use the modeled population of the CHAMPUS-PPO obstetrics patients at WACH per case mix (Research Methodology step 6c). If the traditional system's OB population was 40 percent high risk and 60 percent routine and the CHAMPUS-PPO system referral constraints change this to 60 percent high risk and 40 percent routine, then randomly select the records of FY84 OB cases to ensure the modeled sample estimates the postulated population by case mix (60 percent high risk and 40 percent routine). Based on the retrospective study of their service utilization and cost, project the coefficients and variables above and formulate an average cost comparison standard for the modeled population.

APPENDIX E
ESTIMATED COST BY VARIABLE

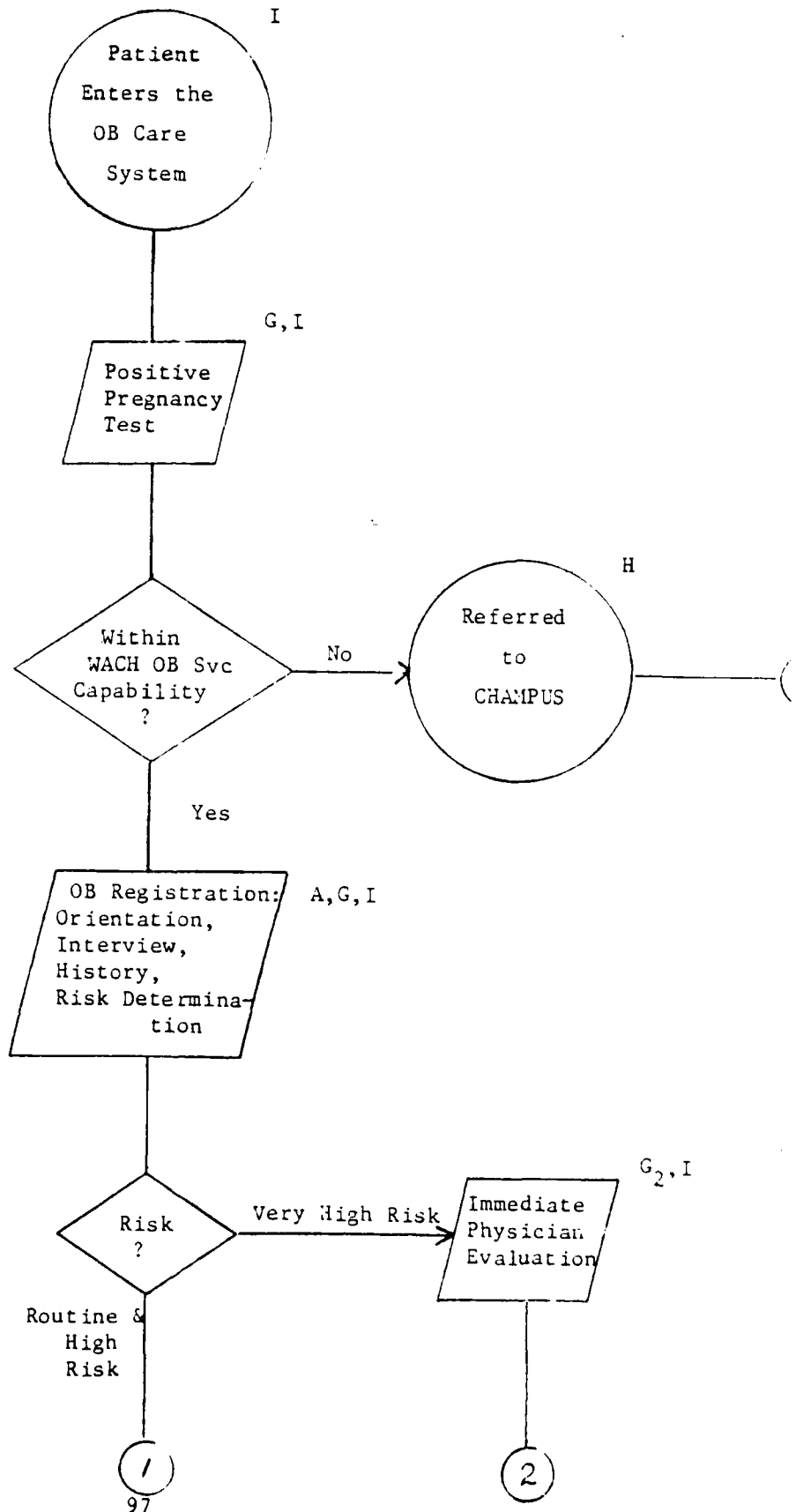
APPENDIX E
COST BY VARIABLE

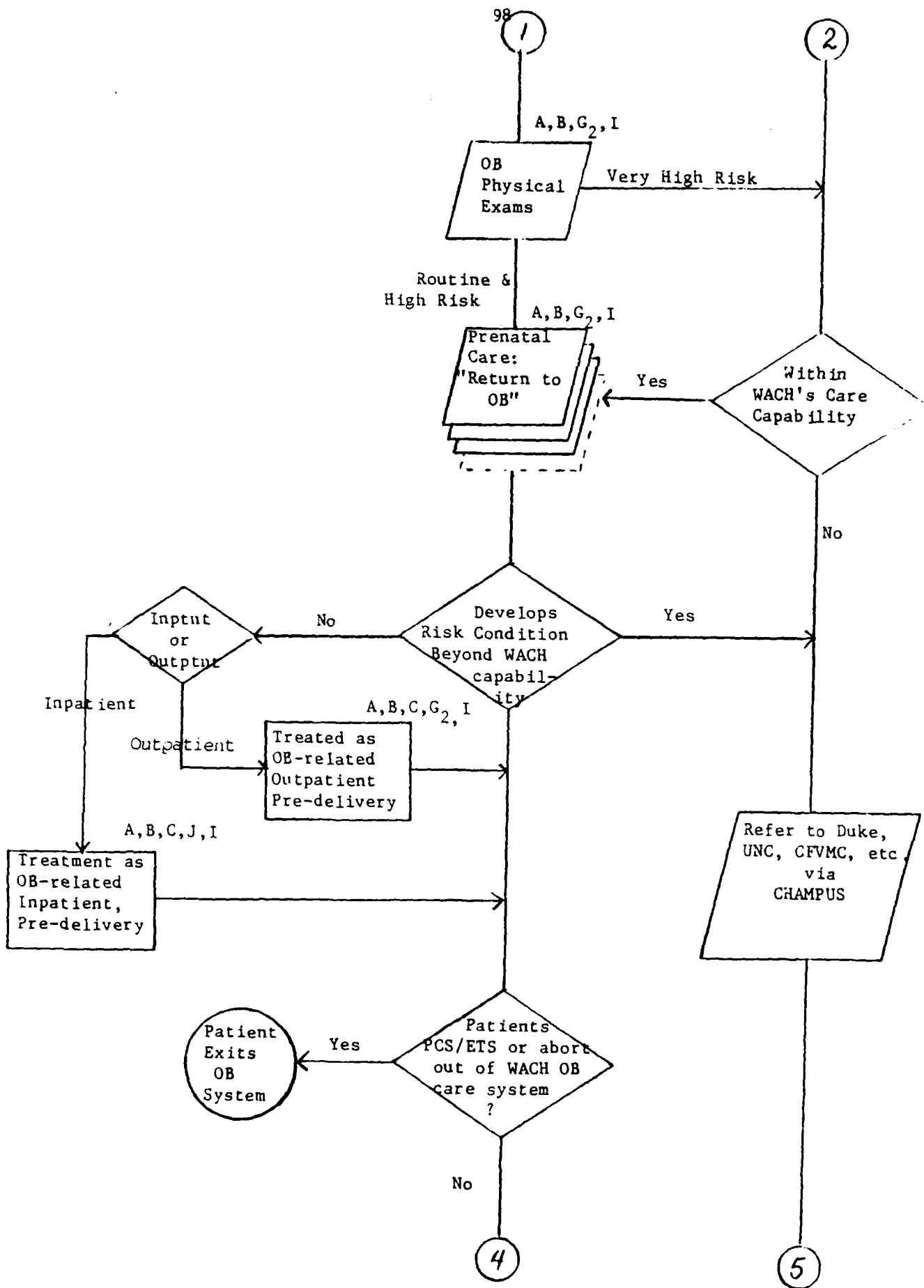
1. OB/GYN Outpatient Clinic Visits:	\$18.19/visit ¹
2. Ultrasound Testing:	\$45.12/test ²
3. Pathology Services:	
a. Rh factor	\$ 2.48/test
b. CBC/WBC	\$ 1.98/test
c. Urinalysis	\$ 1.98/test
d. Glucose	\$.30/test
e. Microbiology	\$ 2.48/tests ⁴
f. Pregnancy test	\$ 2.48/test
g. Rubella	\$ 2.48/test
h. RPR	\$ 2.48/test
i. Herpes check	\$12.00/test
4. Pharmacy Services:	
a. Ampicillin	\$.76/dose
b. Vitamins	\$ 5.04/script
c. Iron tablets	\$ 5.04/script
d. Tylenol	\$.76/dose
e. Tylenol#3	\$.76/dose
f. Terbutaline	\$.76/dose
g. Parlodel	\$ 5.04/script
h. MgSO4	\$10.07/IV
i. Pitocin	\$10.07/IV
j. Oxitocin	\$10.07/sterile

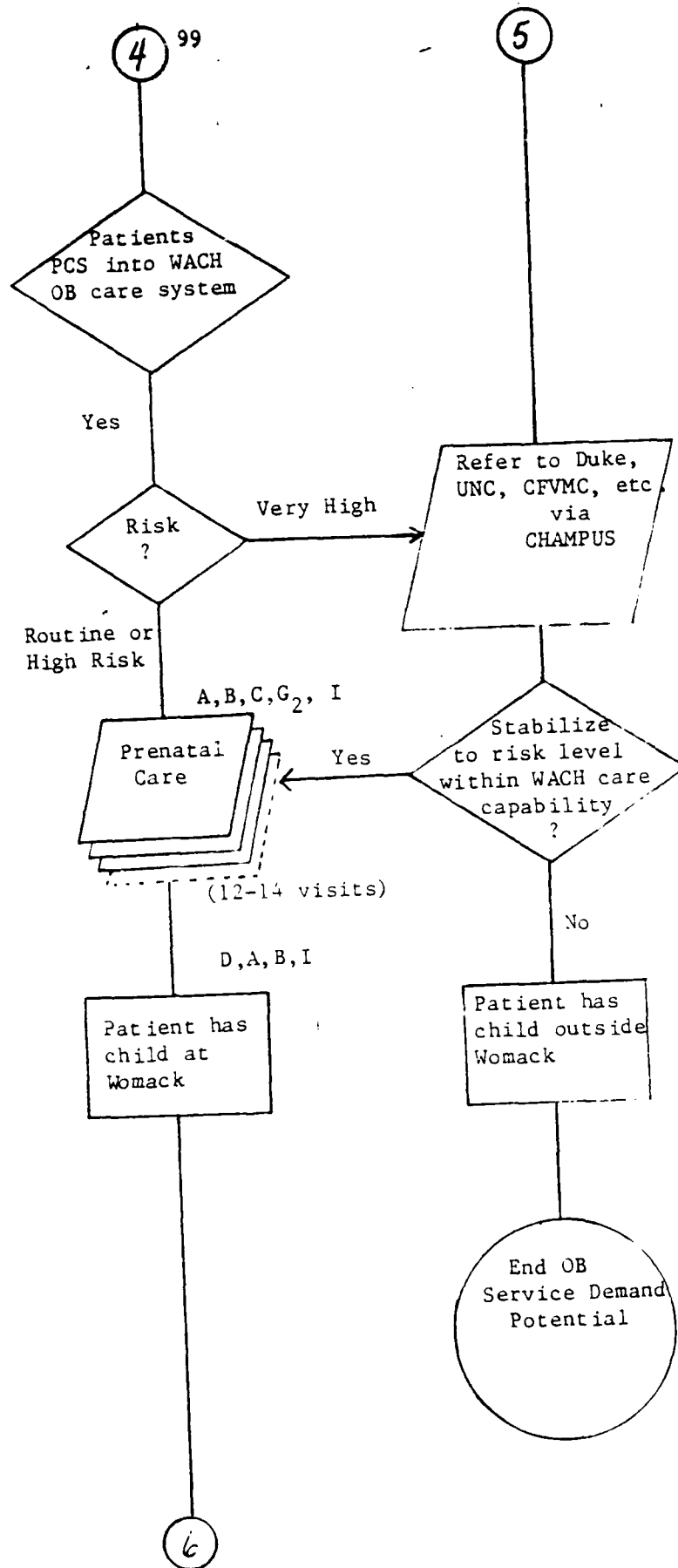
APPENDIX F
EXISTING WACH OBSTETRICS DELIVERY SYSTEM

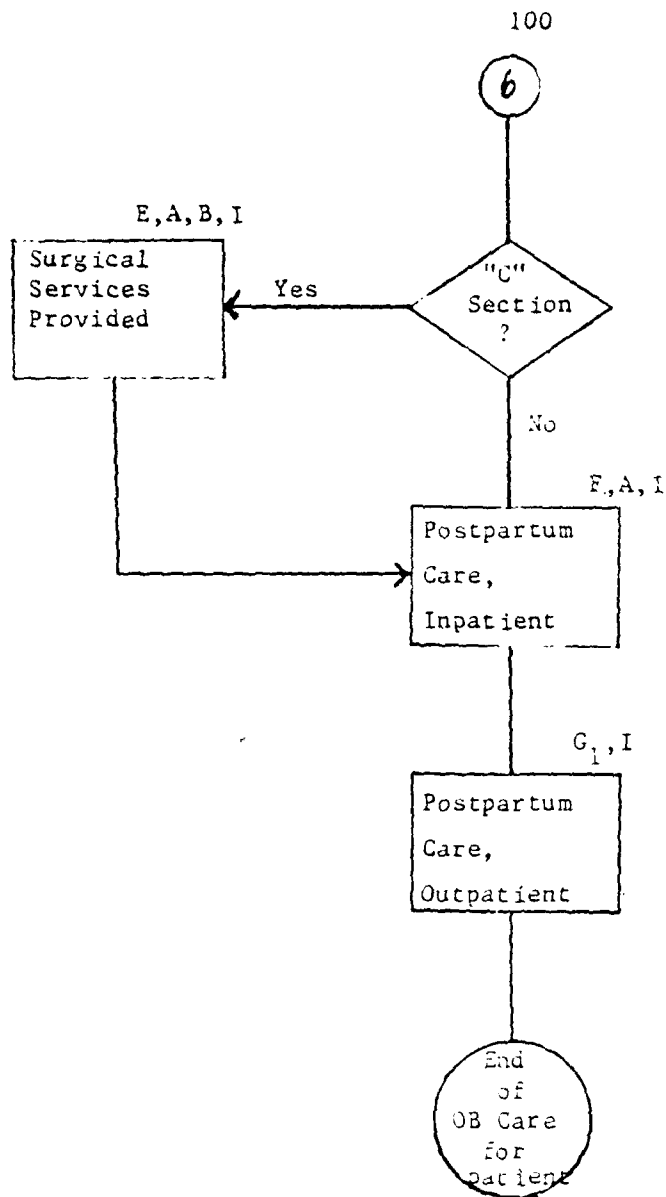
APPENDIX F

EXISTING WACH OBSTETRICS DELIVERY SYSTEM

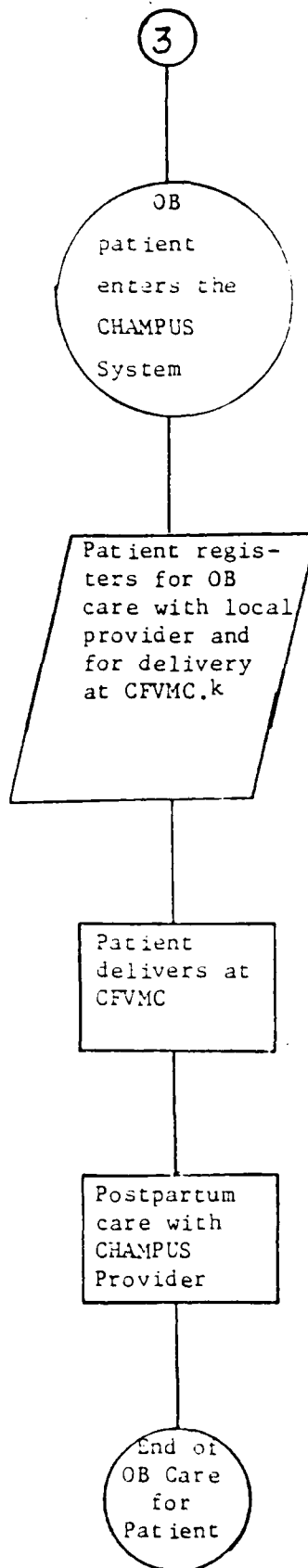








NOTE: A - Pathology Services
 B - Pharmacy Services
 C - Radiology Services
 D - Labor & Delivery Services
 E - Surgery Services
 F - Postpartum Ward Services
 G₁ - Outpatient Clinic Visit with Nurse Practitioner
 G₂ - Outpatient Clinic Visit with Physician Provider
 H - Admin Support of Certificate of Non-availability/Reimbursement
 I - Inpatient & Outpatient Record Cost
 J - Inpatient OB Services, Pre-delivery



NOTE k: Cape Fear Valley
Medical Center

APPENDIX G

FORM FOR COST DATA COLLECTED IN RECORD SCREEN OF SAMPLE

APPENDIX G

FORM FOR COST DATA COLLECTED IN RECORD SCREEN OF SAMPLE

1. Record # _____

2. Type Patient (1st trimester screen)

High Risk _____
Routine _____

Why: _____

3. Number of outpatient visits related to OB treatment regimen?

_____ x 18.19/visit = _____

4. Ultrasound testing visits? _____ x 45.12 = _____

5. Pathology services:

NUMBER OF TESTS

a. Rh factor _____ x 2.48 = _____

b. CBC/WBC _____ x 1.98 = _____

c. Urinalysis _____ x 1.98 = _____

d. Glucos _____ x 0.30 = _____

e. Microbiology _____ x 2.48 = _____

f. Pregnancy test _____ x 2.48 = _____

g. Rubella _____ x 2.48 = _____

h. RPR _____ x 2.48 = _____

i. Herpes _____ x 12.00 = _____

Pathology Subtotal = _____

6. Pharmacy Services

a. Ampicillin _____ x 0.76 = _____

b. Vitamins _____ x 5.04 = _____

c. Iron Tablets _____ x 5.04 = _____

d. Tylenol _____ x 0.76 = _____

e. Tylenol #3	_____	x 0.76 =	_____
f. Terbutaline	_____	x 0.76 =	_____
g. Parlodel	_____	x 5.04 =	_____
h. MgSO ₄	_____	x 10.07 =	_____
i. Pitocin	_____	x 10.07 =	_____
j. Oxitocin	_____	x 10.07 =	_____
k. 1% Lidocaine	_____	x 10.07 =	_____
l. Doxidan	_____	x 0.76 =	_____
m. Nubain	_____	x 10.07 =	_____
n. Phenegran	_____	x 10.07 =	_____
o. Metamucil	_____	x 5.04 =	_____
p. Delfin foam	_____	x 5.04 =	_____

Pharmacy Subtotal _____

7. Number of inpatient days? _____ x 223.90 = _____

8. Surgical procedures?

a. Anesthesia	_____	x 82.56 =	_____
b. Surgery	_____	x 62.56 =	_____
c. Recovery	_____	x 54.50 =	_____

Surgery Subtotal = _____

9. Other cost factors? _____

Total Cost in Sampled Record = _____

APPENDIX H

STEPWISE REGRESSION ANALYSIS OF TOTAL COST USING
COST VARIABLES DAYS, OUTPT, US, PHARM, PATH, SURG, AND RISK

APPENDIX H

STEPWISE REGRESSION ANALYSIS OF TOTAL COST USING VARIABLES DAYS, OUTPT, US, PHARM, PATH SURG AND RISK

STEP 1. Dependent Variable Independent Variable
TOTAL DAYS

Summary of Stepwise Results

No. of Variables Entered	=	1
Number of Steps Executed	=	1
Multiple R	=	0.972275
R-Squared	=	0.945319
Std Error of Estimate	=	100.2407

Analysis of Variance

	<u>Sums of Squares</u>	<u>Degrees of Freedom</u>	<u>Mean Squares</u>	<u>F-Ratio</u>
Regression	--	1	---	1780.651
Residual	1034964.000	103	10048.190	
Total	--	104		

Variables Entered in Equation

Variables	Coefficient	Std Error	F-to-Remove	T-Value
Constant	183.6533			
Days	267.9535	6.3499	1780.6500	42.1978

STEP 2. Dependent Variable Independent Variable
TOTAL DAYS; SURG

Summary of Stepwise Results

No. of Variables Entered	=	2
Number of Steps Executed	=	2
Multiple R	=	0.986025
R-Squared	=	0.972245
Std Error of Estimate	=	71.7651

Analysis of Variance

	<u>Sums of Squares</u>	<u>Degrees of Freedom</u>	<u>Mean Squares</u>	<u>F-Ratio</u>
Regression	---	2	9200982.000	1786.250
Residual	525323.000	102	5150.226	

Variables Entered in Equation

Variables	Coefficient	Std Error	F-to-Remove	T-Value
Constant	2.5944			
Days	242.4128	5.2210	2155.7510	46.4301
Surg	242.9284	24.4208	98.9550	9.9476

STEP 3. Dependent VariableIndependent Variable(s)

TOTAL

Days; Surg; Path

Summary of Stepwise Results

No. of Variables Entered	=	3
Number of Steps Executed	=	3
Multiple R	=	0.988516
R-Squared	=	0.977163
Std Error of Estimate	=	65.4189

Analysis of Variance

	<u>Sums of Squares</u>	<u>Degrees of Freedom</u>	<u>Mean Squares</u>	<u>F-Ratio</u>
Regression	---	3	6165015.000	1440.548
Residual	432242.900	101	4279.632	
Total	---	104		

Variables Entered in Equation

Variables	Coefficient	Std Error	F-to-Remove	T-Value
Constant	-46.9523			
Days	233.5601	5.1239	2077.7440	45.5823
Surg	203.3574	23.8235	72.8634	8.5360
Path	6.7029	1.4373	21.7496	4.6636

STEP 4. Dependent VariableIndependent Variable(s)

TOTAL

Days; Surg; Path; US

Summary of Stepwise Results

No. of Variables Entered	=	4
Number of Steps Executed	=	4
Multiple R	=	0.992434
R-Squared	=	0.984926
Std Error of Estimate	=	53.4148

Analysis of Variance

	<u>Sums of Squares</u>	<u>Degrees of Freedom</u>	<u>Mean Squares</u>	<u>F-Ratio</u>
Regression	---	4	4660494.000	1633.461
Residual	285314.100	100	2853.140	
Total	---	104		

Variables Entered in Equation

Variables	Coefficient	Std Error	F-to-Remove	T-Value
Constant	-66.2653			
Days	230.7858	4.2015	3017.1960	54.9290
Surg	214.4840	19.5137	120.8126	10.9915
Path	5.5484	1.1845	21.9409	4.6841
US	46.9808	6.5468	51.4972	7.1762

STEP 5. Dependent VariableIndependent Variable(s)

TOTAL

Days; Surg; Path; US; Output

Summary of Stepwise Results

No. of Variables Entered	=	5
Number of Steps Executed	=	5
Multiple R	=	0.997405
R-Squared	=	0.994817
Std Error of Estimate	=	31.4787

Analysis of Variance

	<u>Sums of Squares</u>	<u>Degrees of Freedom</u>	<u>Mean Squares</u>	<u>F-Ratio</u>
Regression	---	5	3765838.000	3800.377
Residual	98100.240	99	990.912	
Total	---	104		

Variables Entered in Equation

<u>Variables</u>	<u>Coefficient</u>	<u>Std Error</u>	<u>F-to-Remove</u>	<u>T-Value</u>
Constant	-185.7905			
Days	233.9009	2.4864	8849.3790	94.0713
Surg	201.7629	11.5371	305.8367	17.4882
Path	3.7426	0.7103	27.7609	5.2689
US	43.7594	3.8653	128.1665	11.3211
OUTPT	16.1155	1.1724	188.9309	13.7452

STEP 6. Dependent Variable

TOTAL

Independent VariablesDays; Surg; Path; US; Outpt;
PharmSummary of Stepwise Results

No. of Variables Entered	=	6
Number of Steps Executed	=	6
Multiple R	=	0.998045
R-Squared	=	0.996093
Std Error of Estimate	=	27.4701

Analysis of Variance

	<u>Sums of Squares</u>	<u>Degrees of Freedom</u>	<u>Mean Squares</u>	<u>F-Ratio</u>
Regression	---	6	3142223.000	4164.056
Residual	73951.410	98	754.606	
Total	---	104		

Variables Entered in Equation

<u>Variables</u>	<u>Coefficient</u>	<u>Std Error</u>	<u>F-to-Remove</u>	<u>T-Value</u>
Constant	- 196.2103			
Days	227.7955	2.4234	8835.7490	93.9988
Surg	195.1854	10.1348	370.9049	19.2589
Path	3.9152	0.6206	39.7978	6.3085
US	43.7579	3.3731	168.2907	12.9727
Outpt	16.1205	1.0231	248.2486	15.7559
Pharm	2.3370	0.4131	32.0019	5.6570

STEP 7. Dependent Variable

TOTAL

Independent Variable(s)Days, Surg; Path; US; Outpt;
Pharm; RiskSummary of Stepwise Results

No. of Variables Entered	=	6
Number of Steps Executed	=	6
Multiple R	=	0.998045
R-Squared	=	0.996093
Std Error of Estimate	=	27.4701

Analysis of Variance

	<u>Sums of Squares</u>	<u>Degrees of Freedom</u>	<u>Mean Squares</u>	<u>F-Ratio</u>
Regression	---	6	3142223.000	4164.056
Residual	73951.410	98	754.606	
Total	---	104		

Variables Entered in Equation*

Variables	Coefficient	Std Error	F-to-Remove	T-Value
Constant	-196.2103			
Days	227.7955	2.4234	8835.7490	93.9988
Surg	195.1854	10.1348	370.9049	19.2589
Path	3.9152	0.6206	39.7978	6.3085
US	43.7579	3.3731	168.2907	12.9727
Outpt	16.1205	1.0231	248.2486	15.7559
Pharm	2.3370	0.4131	32.0019	5.6570

*NOTE: The Risk Variable Failed the F Criterion for Entry
into the Equation

APPENDIX I

REVISED FORM FOR COST DATA COLLECTION FOR FUTURE STUDIES

APPENDIX I
DATA COLLECTION FORM

1. Record # _____
2. Type Patient (1st trimester screen)
 High risk? _____ Why? _____
 Routine? _____
3. Number of outpatient visits related to OB treatment regimen?
 _____ x \$ _____/visit = _____
4. Number of inpatient days? _____ x \$ _____/day = _____
5. Surgical procedures?
 - a. Anesthesia? _____ x 82.56 = _____
 - b. Surgery? _____ x 62.56 = _____
 - c. Recovery? _____ x 54.50 = _____

Surgery Subtotal = _____
6. Other cost factors? _____
 Total Cost in Sampled Record = _____

APPENDIX J

SAMPLE BIRTHING CENTER RISK CRITERIA/SYSTEM

[Extracted from Health Policy and Nursing Practice
edited by Linda H. Aiken (McGraw-Hill, 1980)]

APPENDIX J

The following criteria will be applied to all women by professional staff during the antepartum, intrapartum, and postpartum periods.

A cumulative score of 2 points on the Initial Score Sheet indicates the woman is at a risk incompatible for project care. Accepted women will be continuously evaluated for presence of any listed antepartum, intrapartum, or postpartum criteria and be referred or transferred to the backup facility or physician.

SCORE

PROBLEM DESCRIPTION

1. Initial Data Base

SOCIODEMOGRAPHIC FACTORS

- | | |
|---|---|
| 2 | Chronological age: 40 and over nulliparous |
| | 45 and over multiparous |
| 2 | Permanent residence outside specified target area |

DOCUMENTED PROBLEMS IN MATERNAL MEDICAL HISTORY

Cardiovascular

- | | |
|---|--------------------------|
| 2 | Chronic hypertension |
| 2 | Heart disease |
| 2 | Pulmonary embolus |
| 2 | Congenital heart defects |

Urinary System

- | | |
|---|---|
| 2 | Renal disease moderate to severe including nephritis or chronic renal disease |
| 1 | One episode of pyelonephritis prior to this pregnancy |

Psychoneurological

- | | |
|---|---|
| 1 | Previous psychotic episode adjudged by psychiatric evaluation |
| 2 | Current mental health problem adjudged significant by psychiatric evaluation and/or required use of drugs related to its management |
| 1 | Epilepsy or seizures |
| 2 | Required use of anticonvulsant drugs |

SCOREPROBLEM DESCRIPTIONDOCUMENTED PROBLEMS IN MATERNAL OBSTETRICAL HISTORY

Previous Abortions

- 2 3 or more spontaneous (28 weeks)
- 2 1 septic

Uterus

- 2 Previous uterine surgery including cesarean section (if previous tubal pregnancy and enrollment before 16 weeks, accept conditionally)
- 0-2 Cone biopsy (at discretion of MD)
- 2 Previous placenta abruptio
- 1 Previous placenta previa and/or significant third trimester bleeding
- 2 Severe hypertensive disorder during previous pregnancy
- 2 Postpartum hemorrhage apparently unrelated to management

History of prolonged labor

- 1 Primipara-Stage 1 24 h; Stage 2 3 h; and/or Stage 3 1h
- Multipara-Stage 1 18 h; Stage 2 2 h; and/or Stage 3 1h

DOCUMENTED PROBLEMS IN PREVIOUS INFANTS

- 1 Stillbirth (28 weeks' gestation)
- 1 Birthweight 2500 g or 4000 g
- 1 Major congenital malformations
- 1-2 Genetic/metabolic disorder (genetic counseling)

MATERNAL PHYSICAL FINDINGS

- 2 Gestation
 - More than 22 weeks, nulipara
 - More than 28 weeks, multipara (except when mother has attended classes for previous birth and is currently receiving prenatal care)
- 2 Weight for height outside intervals on attached chart
- 0-2 Clinical evidence of uterine myoma (evaluated by MD)
- 2 Polyhydramnios or oligohydramnios
- 2 Cardiac diastolic murmur, systolic murmur grade 3 or above, and/or cardiac enlargement
- 2 Pelvimetry indicative of inadequacy to deliver an infant of 3100 g

SCOREPROBLEM DESCRIPTIONDOCUMENTED PROBLEMS IN MATERNAL MEDICAL HISTORY

- 2 Drug addiction (heroin, barbiturates, alcohol, etc.),
current use of addicting drugs or current therapy
related to these addictions
- 2 Severe recurring migraines
- Endocrine
- 2 Diabetes mellitus
- Thyroid disease
- 1 History of thyroid surgery
- 2 Enlarged thyroid gland with symptoms of thyroid disease
based on T3 or T4
- 1 Current use of thyroid-related medications
- Respiratory
- 1 Asthma and/or chronic bronchitis within the last 5 years
- Other systems
- 2 Bleeding disorder and/or hemolytic disease
- 1 Sensitivity to local anesthetics ("caines")
- 2 Previous radical breast surgery
- 2 Other serious medical problems

SCOREPROBLEM DESCRIPTIONDOCUMENTED PROBLEMS IN MATERNAL OBSTETRICAL HISTORY

- 0-2 EDC less than 12 months from date of previous delivery
(evaluated individually)
- 2 Previous Rh sensitization
- 2 Parity of 5 or more
- Infertility problems
- 1 Workup and counseling of more than three years' duration
prior to this pregnancy
- 0-2 Use of fertility drugs to achieve this pregnancy (evaluated
by MD)

SCOREPROBLEM DESCRIPTIONLABORATORY AND RADIOLOGIC FINDINGS

Hematocrit

- 1 Hct less than 31%
- 2 Hct less than 28%
- 2 3S hemoglobin
- 2 Pap smear class 3 or greater with positive colposcopy
- 2 Evidency of active tuberculosis

II. Antepartum Referral Factors

- 2 Hct less than 34% if entering the 37th week of gestation
- 2 Multiple gestations affirmed by sonogram
- 2 Evidence of fetal chromosomal disorder in amniotic fluid
- 2 Development of symptoms of preeclampsia
- 2 Intrauterine growth retardation
- 2 Thrombophlebitis
- 2 Pyelonephritis
- 2 Symptoms of gestational diabetes affirmed by abnormal glucose tolerance curve
- 2 Development of unexplained vaginal bleeding
- 1 Abnormal weight gain (<12 or >50 lb)
- 1 Nonvertex presentation persisting past 37th week of gestation
- 2 Laboratory evidence of sensitization in Rh-negative women
- 2 Postmaturity (42 weeks/294 days gestation)
- 1 Documented asthma attack
- 2 Positive herpes culture at time of labor
- 2 Development of any other severe obstetrical, medical, and/or surgical problem
- 2 Circumstantial factors: Medical team staff decision, after taking into account and review all of the family circumstances, including composition, general physical condition, and total situation, that childbearing in this case would be best accomplished under the supervision of a physician in a more traditional medical setting, i.e.:
- 2 Lack of available support person to be in the home during the first 3 postpartum days
- 2 Lack of source of obstetrical follow-up after 28 weeks of gestation
- 2 Lack of source of pediatric follow-up after 34 weeks of gestation
- 2 Consistent nonattendance at classes and/or office hours

SCOREPROBLEM DESCRIPTION

III. Intrapartum and Postpartum Transfer Factors

- 2 Premature labor (less than 37 weeks' gestation)
- 2 Premature rupture of membranes (greater than 12 h before onset of regular contractions)
- 2 Nonvertex presentation

Evidence of fetal distress

- 2 Abnormal heart tones
- 1-2 Meconium staining
- 2 Estimated fetal weight less than 2500 g or greater than 4000g
- 2 Development of hypertension

Failure to progress in labor

- 2 First stage: lack of steady progress in dilation and descent after 24 h in nullipar and 18 h in multipar
- 2 Second stage: more than 2 h without progress in descent
- 2 Third stage: more than 1 h
- 2 Prolapse of cord
- 2 Soft tissue problems:
 - Severe vulvar varicosities
 - Marked edema of cervix

Blood Loss

- 2 Intrapartum bleeding greater than 500 cc
- 1-2 Postpartum hemorrhage (over 500 cc) controlled and stable vital signs (consult obstetrician regarding hospitalization)
- 2 Development of other severe medical/surgical problem
- 2 Evidence of active infectious process
- 2 Any condition requiring more than 12 h of postpartum observation

IV. Infant Transfer Factors

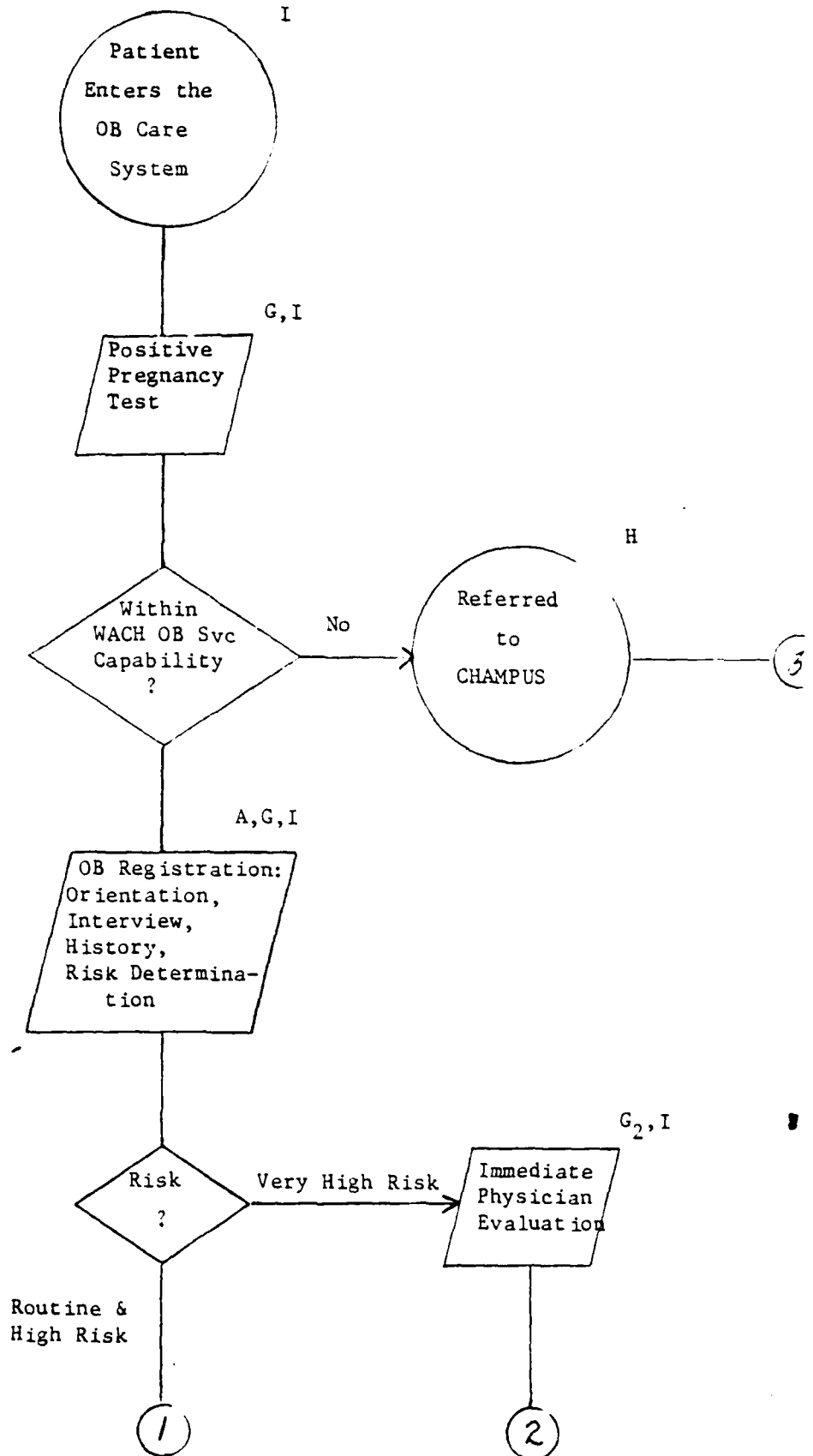
- 2 Apgar score less than 7 at 5 minutes
- 2 Signs of pre- or postmaturity
- 1 Weight under 2500g (pediatrician to determine whether hospitalization is necessary)
- 2 Respiratory problem
- 2 Jaundice
- 2 Persistent hypothermia (less than 97°F (36.1°C), rectal after 2 h of life)
- 2 Exaggerated tremors
- 2 Major congenital anomaly
- 2 Any condition requiring more than 12 h observation post-delivery

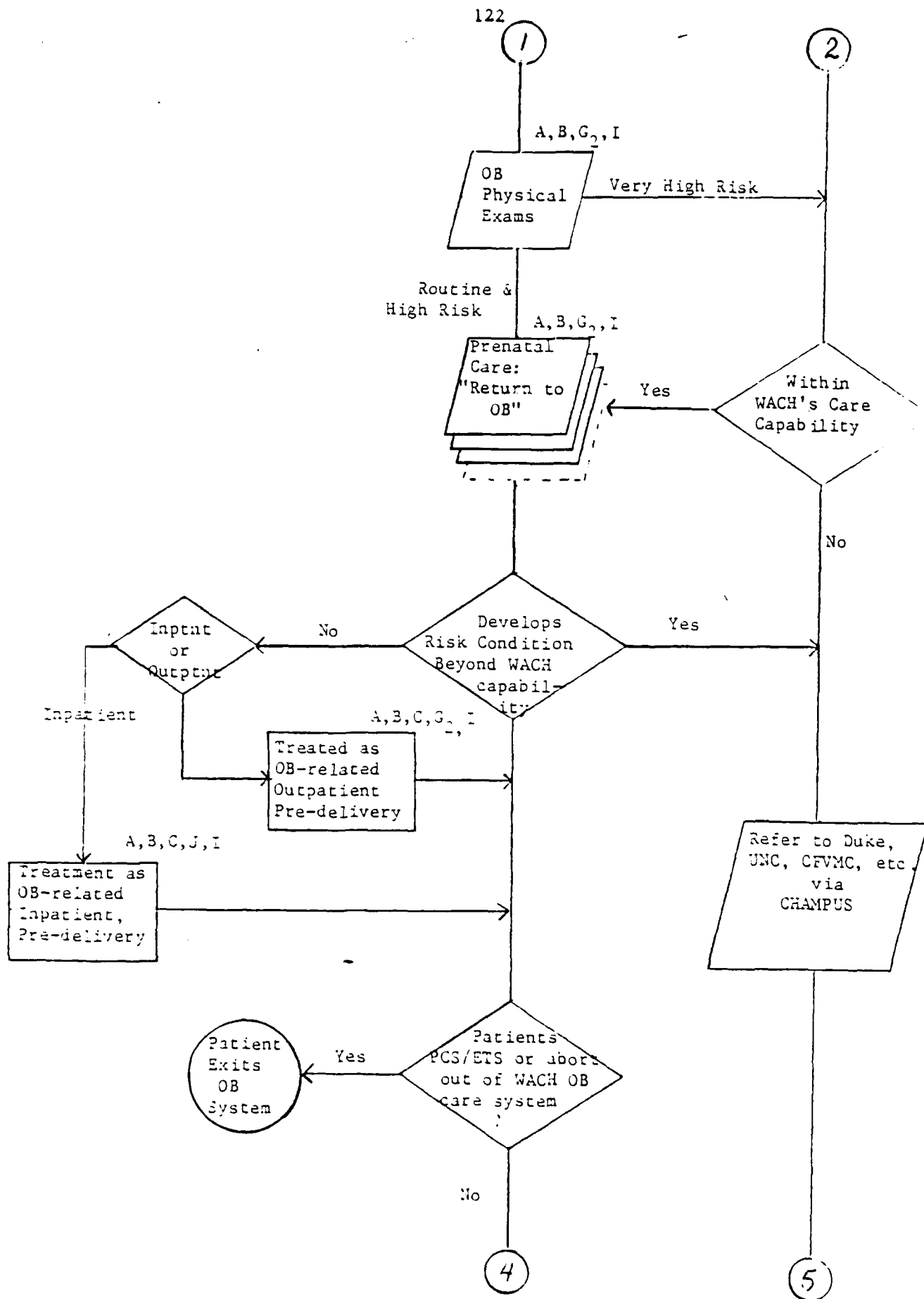
APPENDIX K

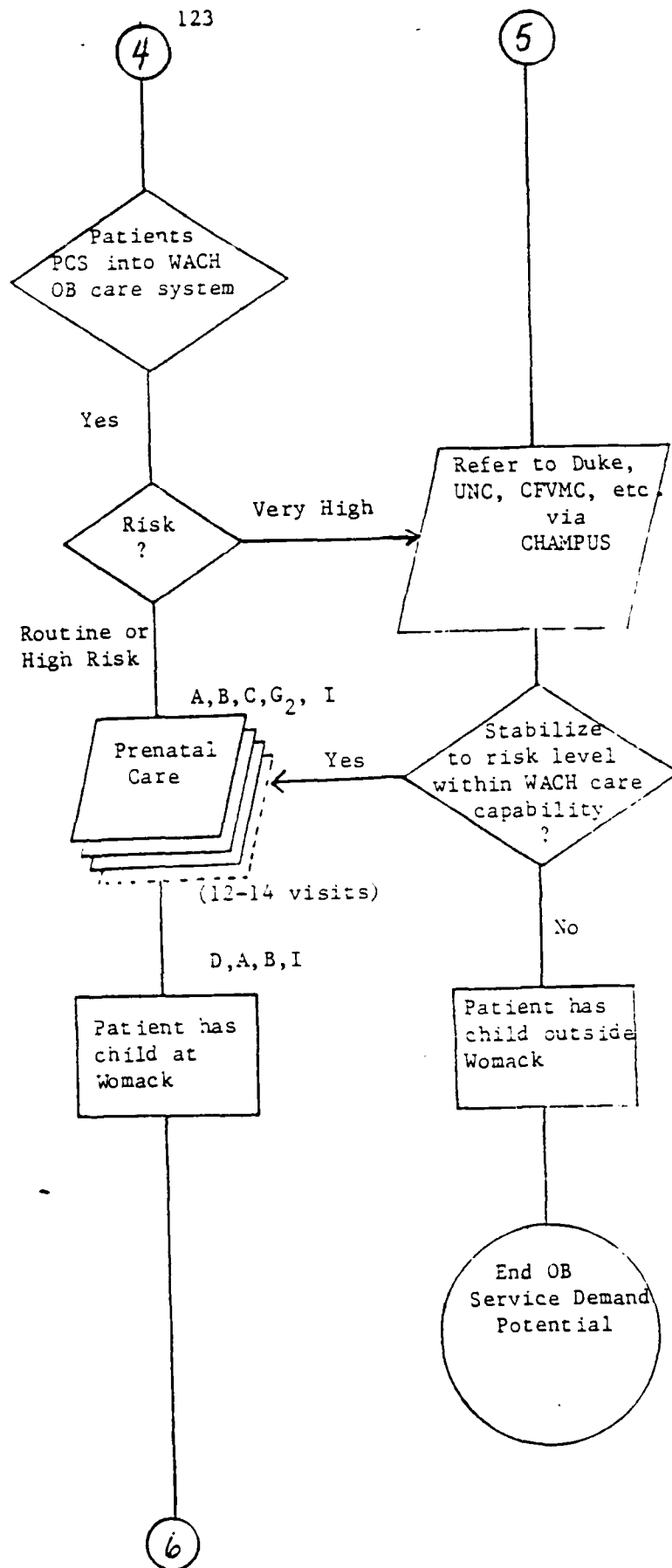
PROPOSED WACH OBSTETRICS DELIVERY SYSTEM AFTER
CHAMPUS-PPO IMPLEMENTATION

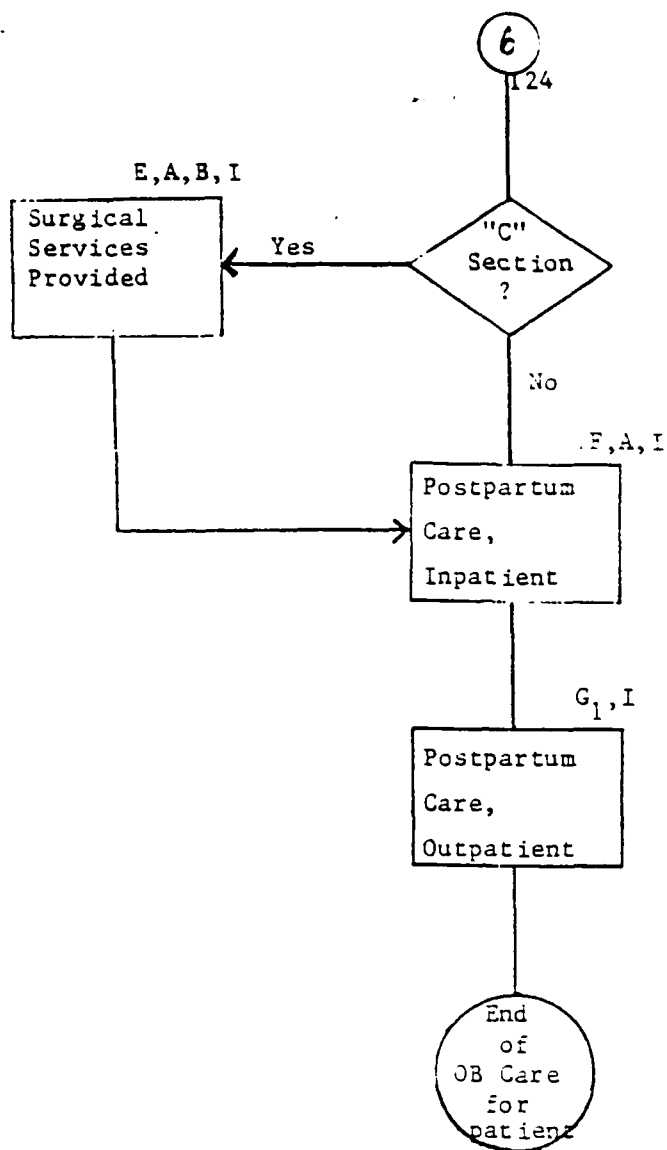
APPENDIX K

PROPOSED WACH OBSTETRICS DELIVERY SYSTEM AFTER CHAMPUS-PPO IMPLEMENTATION

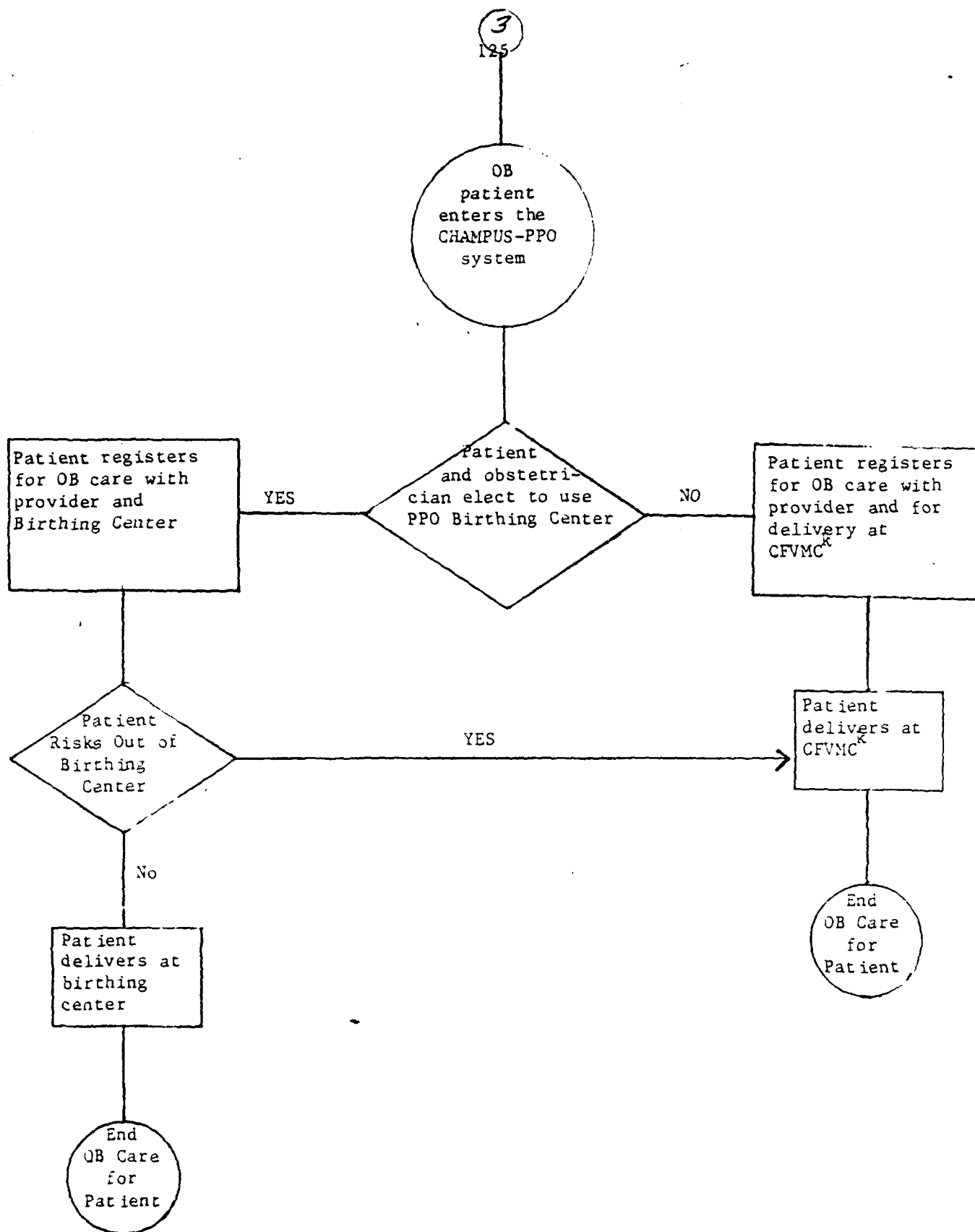








NOTE: A - Pathology Services
 B - Pharmacy Services
 C - Radiology Services
 D - Labor & Delivery Services
 E - Surgery Services
 F - Postpartum Ward Services
 G - Outpatient Clinic Visit with Nurse Practitioner
 G⁺ - Outpatient Clinic Visit with Physician Provider
 H - Admin Support of Certificate of Non-availability/Reimbursement
 I - Inpatient & Outpatient Record Cost
 J - Inpatient OB Services, Pre-delivery



NOTE ^k: Cape Fear Valley Medical Center

APPENDIX L

GLOSSARY

APPENDIX L

GLOSSARY

1. Average Cost. The cost per unit of production. Total cost divided by the relevant level of output.
2. Birthing Center. An out-of-hospital facility equipped to provide normal maternity care to carefully screened families anticipating a healthy childbirthing experience.
3. Case Mix. The proportion of patients falling into mutually exclusive case types.
4. Catchment Area. The statutory zone of residence prescribed for Department of Defense beneficiaries limiting their use of inpatient health care services to military treatment facilities as long as the services are available and they reside in that zone surrounding the facility.
5. Certificate of Nonavailability. Preauthorization (based upon "nonavailability" of services at military treatment facilities) for treatment in nonmilitary facilities for beneficiaries living within the statutory zip code zone requiring the use of military treatment facility services if they are available.
6. Cesarean Section. A surgical procedure involving an incision through the abdominal and uterine walls for delivery of a fetus.
7. Charge. An amount billed to a customer for a service/product which normally includes operational cost and a profit margin.
8. Coefficient of Multiple Determination (r^2). The proportion of the dispersion (or total variation) of the observed values of the independent variable (Y) about their mean (\bar{Y}) that is explained by the independent variable (X) in the regression equation. An objective measure of how well the regression equation accounts for the variability of Y about its mean (\bar{Y}); the "goodness of fit".
9. Correlation Analysis. A process for studying the strength of the relationships between variables.
10. Multiple Correlation Coefficient (r). A measure of the strength of the linear relationship between variables.

11. Cost Center. A point of assignment for cost within an organization; ideally an organizational responsibility center.
12. Dependent Variable. The variable being estimated (Y) by the independent variables (x_n).
13. Dummy Variable. An indicator variable established with an arbitrary finite set of numerical values (i.e. 0 and 1 or 1 and 2) to measure the impact on the dependent variable of a nominal independent variable in a regression model.
14. Explained Error. That amount of variation of the values for Y about its mean (\bar{Y}) explained by the regression equation.
15. Fixed Cost. The cost that would have been incurred even if no output had been produced by a firm ready to produce.
16. Frequency Polygon. A frequency distribution in which observations are listed on the Y-axis in intervals and the frequency of their occurrence in these intervals is plotted as points directly over the mid-point of the class interval corresponding to the frequency scale of the X-axis.
17. Hypothesis, Null. The hypothesis of no relationship or difference. The hypothesis actually tested. An arbitrary convention hypothesizing that any relation or difference in the findings is due to chance or sampling error and puts this supposition to a probability test.
18. Hypothesis, Alternate. The alternate hypothesis (or research hypothesis) states the expectations of the researcher in positive terms identifying the variables, which in causal relationship, will be advanced to account for the research results.
19. Independent Variable. The explanatory variables usually controlled by the researcher and represented by the letter X.
20. Intrapartum. Occuring during childbirth or during delivery.
21. Normal Distribution. The Gaussian distribution. A family of symmetrical probability distributions of continuous nature whose range extends between negative and positive infinity. A normal distribution is characterized by an equal mean, median, and mode as well as a standard deviation specific for the population that it represents. This allows one to predict probabilities of occurrence within a population of randomly distributed observations using the corresponding area under the probability curve.

22. Obstetrics. The branch of surgery which deals with the management of pregnancy, labor, and the puerperium (period of confinement after delivery).

23. Outliers. Observations falling outside a reasonably probable range of the sampled set of observations of a population distribution.

24. Perinatal. An adjective pertaining to or occurring in the period shortly before and after birth.

25. Population Mean. A measure of central tendency equal to the sum of all the values in a population divided by the number of values in the population. The arithmetic average of a set of values.

26. Prenatal. An adjective pertaining to the period existing or occurring before birth, with reference to the fetus.

27. Regression Analysis. A procedure for studying the probable form of the relationship between variables with the ultimate objective to estimate the value of one variable (the dependent variable, Y) corresponding to given values of other variables (independent variables, X).

28. Severity-of-Illness. The risk of immediate death or permanent loss of function due to a patient's disease. The acuity of a patient's disease incorporating:

- a. Stage of the principle diagnosis.
- b. Complications of the principle condition.
- c. Concurrent interacting conditions that affect the hospital course.
- d. Dependency on hospital staff.
- e. Extent of nonoperating room procedure.
- f. Rate of response to therapy.
- g. Impairment remaining after therapy for the acute aspect of the hospitalization.

29. Student t-value. A value in the Student t-value distribution that, adjusted for degrees of freedom, allows one to study the probability of occurrences against statistical critical values in a population distribution at selected levels of significance.

30. Sturges Rule. To establish the class intervals in a frequency distribution that are contiguous, non-overlapping, and sufficient in number, Sturges's formula is used. This formula gives $k = 1 + 3.322 (\log_{10} n)$

where: K = number of class intervals

n = the number of values in the data set.

31. Total Cost. The total money expended on producing some level of output.

32. Ultrasound (ultrasonography). The visualization of deep structures of the body by recording the reflections (echoes) of pulses of ultrasonic waves directed into the tissues.

33. Variable Cost. The cost that is directly related to output.

34. Variance. A measure of dispersion of values relative to their mean.

35. Variance Ratio. A ratio of the mean squared error explained by the regression equation to the mean squared error not explained by the regression equation.

36. Z-value. the random variable assigned a probability value that results when the difference between an observed value in a population (x) and the population mean (U) are divided by the population standard deviation (σ). On a standardized normal distribution the z-value equals a number of standard deviations away from the population mean associated with a random variable.

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