Development of a Diagnosis Related Management System
for the Department of OBGYN
at Winn Army Community Hospital, Ft. Stewart, Georgia

A Graduate Management Project

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This paper examines the development of a diagnosis related management system for Obstetrical and Gynecological Diagnosis Related Groups at Winn Army Community Hospital, Ft. Stewart, GA. Linear Programming was used to create an objective function that maximized the relative weighted products that result from the DRG tracked workload. The program's objective was to examine the DRGs on a case mix aaproach and maximize the highest sum of the relative weighted products to achieve the highest reimbursement possible. This program considered the physical limitations of the physicians based on available time and the time required to perform certain procedures The program produced an optimal relative weighted product that recommends how much of each DRG should be performed based on the variables and constraints within the facility.

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Abstract

This paper examines the development of a diagnosis related management system for Obstetrical and Gynecology Diagnosis Related Groups at Winn Army Community Hospital, Ft. Stewart Georgia. There are 27 OB-GYN DRGs listed in the DRG Definitions Manual (354-384). The hospital recorded a total of 1,789 dispositions in those DRGs for Fiscal Year 1988. Due to the large number of CHAMPUS requests for OB-GYN cases and the inception of a DRG based cost system in the military, it was necessary to examine a case mix approach to increasing reimbursements by obtaining the highest relative weighted product possible. Linear programming was used to create an objective function that maximized the relative weighted products that result from the DRG tracked workload. This program considered the physical limitations of the physicians and the time available to perform each procedure. The program produced an optimal relative weighted product that recommends how much of each DRG should be performed based on the variables and constraints within the facility. Administrators may use this relative weighted product to recommend which of the

higher reimbursable procedures should be retained by the medical treatment facility (MTF) while identifying alternative courses of treatment for the lower reimbursable DRGs.

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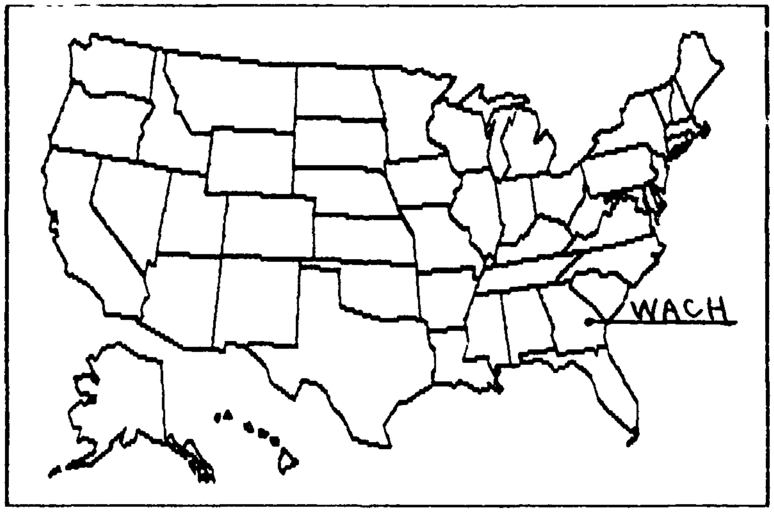
Conditions Which Prompted the Study

Public Law (PL) 100-180 directed that DRG based resource allocation be implemented within Medical Treatment Facilities (MTF) within the Department of Defense (DOD) Military Health Care System. This transition will take place over the next several years in order to minimize the effects of this methodology and provide time for all levels of management and clinical services to adjust to this type of resource allocation. For the first year the only funds affected will be supply dollars (DOD Object class 26) in Program Elements Codes (PECs) 0807711 - Care in Regional Defense Facilities and 0807792 - Station Hospitals and Clinics (Mayer). So far MTFs have not received adequate training, software, or hardware to track the patient loads by DRGs. This "hole" in the system will cause many MTFs to unnecessarily lose supply dollars due to the inability to manage by DRGs. The Ft. Stewart Medical Department Activity (MEDDAC) is no exception. According to the FY 1988 first quarter review of Medical Composite Care Units (MCCU) to DRGs, the Ft.

Stewart MEDDAC should lose $400,214 if the system was implemented at that time. Fortunately, only 5% of this figure would have been cut, so the loss would have only been $20,011. Based on these events it is vital to the fiscal survival of Winn Army Community Hospital (WACH), that Diagnosis Related Management (DRM) begin immediately.

Winn Army Community Hospital, (Figure 1) located in Ft. Stewart, Georgia, is a 341,000 square foot complex that has a bed capacity of 165 inpatients in

Figure 1
Location of Ft. Stewart, GA.



seven inpatient care units. In addition it has six operating rooms, a six bed intensive care unit, a six bed same day surgery unit, and six labor and delivery rooms. The MEDDAC has an authorized staff of 820 which supports the 24th Infantry Division (Mech) and a catchment area of 58,000 beneficiaries.

In early FY 89 the Department of Defense developed an initiative which makes CHAMPUS funds available to military hospitals that can demonstrate an overall savings of CHAMPUS dollars by providing care which was previously rendered by a CHAMPUS provider. Winn Army Community Hospital proposed to admit 25 more women per month if it could receive the CHAMPUS dollars to increase its staff. At that time the projected net savings to the government was $543,894, annually (Personal interview, Miller).

A cursory analysis of the workload by DRG for FY 88 shows three of the top four DRGs to be OBGYN related cases. There was a total of 2,083 dispositions in the top five DRGs for FY 88. Table 1 shows the breakdown of these DRGs and the workload of each.

Table 1

Workload of Top 4 DRGs

DRG Code	Title	Disp	%of Disp
391	Normal Newborn	843	13%
373	Vag Deliv	782	12.5%
371	Cesarean Section	187	2.9%
390	Neonates with prob	146	2.3%
383	Other antepart Diag	125	2.0%

These DRGs constituted a total of almost 30% of the total dispositions for FY 88. There were 27 OBGYN DRGs (DRG 354-384) seen at Winn. In November of 1988, Health Services Command (HSC) directed the Alternate Use of CHAMPUS funds in order to prevent the enormous drain on the Champus budget. In response to this WACH looked at several CHAMPUS high use services to ascertain which ones could be tailored to reduce the CHAMPUS expenditures. The most obvious service was OBGYN since it had the highest use of CHAMPUS funds at that time. The OB service averaged 93 live births per month for FY 88 and issued an average of 45 non availability statements (NAS) for OB and 50 NASs for GYN. The staff felt that these women, who were currently being seen on the civilian economy using CHAMPUS funds, could be brought back into the direct care system and receive care at the hospital. This program was called the OB Recapture Program under the Alternate use of CHAMPUS Funds initiative. The recapture program was scheduled to begin on 1 December 1988. The plan was to cease the issuance of NASs in the catchment area (with specific regional exceptions) until the OB and Family Practice Services had at least 125 registered OB patients for a particular month. Deliveries were expected to rise gradually from December through June of 1989 when the goal of 25 additional deliveries per month would be met by the services. The actions for hiring the additional staff would begin in January 1989 using funds allocated under the Alternate Use Initiative. The initial staffing guidelines were calculated using a figure of 20 deliveries per month for each OBGYN physician. The staffing level at that time, 5 OBGYN physicians and 7 Family Practice physicians, was deemed sufficient for the projected 125 deliveries per month. This was broken down to 100 deliveries for the OB service or 20 per physician, and 25 per month for Family Practice. The consultant for OBGYN, however, relayed news that the American College of Obstetricians and Gynecologists (ACOG) had published a standard of care limit of 15 deliveries per month per physician. Thus, additional physicians were needed in order to meet the target of 125 deliveries and to comply with the ACOG standards. The twofold problem of increasing the OB workload and the impending management under DRGs placed the staff in a unique position. The OBGYN DRGs, are traditionally, low reimbursable DRGs, and the mere increase in the workload without a sound management plan could prove disastrous for future funding considerations. So it was imperative that a case mix for these DRGs be calculated to determine which of these cases should be treated within the facility and which cases should be placed on CHAMPUS for treatment while meeting the target goal of 125 deliveries and maintaining quality care for the patients.

Statement of the Management Problem

The problem of this study was to develop a Diagnosis Related Management System by determining the optimal case mix for OBGYN DRGs to maximize the reimbursable weight under the DRG resource allocation methodology.

An optimal case mix approach has been used by industry for years. Case or product mix concept consists of a collection of products which can be sold and a finite set of resources from which these products are made. Associated with each product is a profit contribution rate and a resource usage rate. The objective is to find that mix of products which maximizes profit, making sure that no more resources are used than what is available (Schrage).

The DRG methodology operates on a prospective payment system which allots a reimbursement that corresponds to a particular DRG. Reimbursement for a specific condition is based on a national average treatment cost. The DOD methodology links the reimbursement to a supply dollar amount taking into account facility and regional differences.

The solution for this approach rests squarely upon five assumptions.

1) The number of OBGYN physicians will remain constant. The variable of available physician time was determined using the staffing level for FY 87. In view of the current budget problems it is conceivable that this staffing level may decrease slightly or even increase by one or two physicians.

2) The types of procedures performed during the fiscal year will remain relatively the same over other years.

3) The demographics and the number of the population that Winn Army Community Hospital supports will remain the same. The current population provides a patient base of relatively young, healthy females.

4) The types of procedures that set the minimum and maximum ranges were closely associated with the final DRG assigned.

5) The work patterns of the physicians were derived from the Medical Expense and Performance System (MEPRS) which is assumed to be reliable.

At the same time the study has one limitation that must be recognized. The program only looks at three variables, time and a minimum and maximum range of procedures.

Review of the Literature

DRGs: Concepts and Definitions

A DRG is a homogeneous set of case types or patient groups who consume or require similar resources in terms of treatments, medical supplies, time, etc. Each DRG relates a set of patient's demographic, diagnostic, and therapeutic characteristics to the hospital's resources they consume so that each DRG is differentiated only by those variables related to the patients' conditions and treatment processes that affect the patient's use of hospital services (Hartzke).

The concept of DRGs began in the late 1960s at the Yale University Center for Health Studies. The research team wanted to group similar diagnoses so that patients could be classified by groups that had low variation in lengths of stay. In 1975 the Health Care Financing Administration (HCFA) joined forces with Yale to develop an inpatient payment system based on DRGs (Hartzke).

There are five essential elements required to assign a DRG code to a specific patient. They are as follows:

(1) principal diagnosis - that condition, after study, determined to be chiefly responsible for occasioning the admission of the patient to the hospital;

(2) principal procedure - the main procedure that is performed and related for a principal diagnosis;

procedure most related to the principal diagnosis;

(3) patient's age;

(4) patient's sex;

(5) discharge status (PASBA).

Case Mix Management

The concept of case mix management is extremely important to the administrator in the prospective payment system (PPS) stage of reimbursements. Determining the optimal case mix will give the administrator a sense of what the types and volumes of cases the hospital should be seeing to maximize the reimbursements under the PPS. Effective October 1, 1983, the provisions of PL 98-21 replaced the traditional retrospective mechanism of financing the use of inpatient care by Medicare beneficiaries. Policy 98-21 established a prospective payment system in which prices were established for each of the 467 diagnosis related groups. Predicated on the assumption that prospective payment reduces the rate of increase in hospital costs, the revisions in the payment incurred by the Medicare program. When viewed from the perspective of beneficiaries, such as the institution and the hospital industry, however, the implementation of PL 98-21 may result in a set of undesirable consequences (Rosko, p. 193). When viewed from a position of equity, it is reasonable to assume that all purchasers should pay the same rate for the use of a given service, and that the profit margins of all services should be uniform (Rosko, p. 200).

It is possible to identify a set of services that are used predominately by patients who can pay the full costs. The process of determining the cost of treating patients in each of the DRGs for an individual hospital or a collection of hospitals begins with the assignment of hospital costs to individual DRGs (Hartzke). Costs may then be shifted from insured beneficiaries to the target group by simply increasing the markup that is applied to this group of services (Rosko, p. 200).

The full potential of case mix management is realized when the patient workload for a specific DRG is analyzed. In this example let mk and mi represent the number of patients assigned to a DRGk and DRGi, respectively. And let symbol FCk represent the corresponding full costs, and Rk is the corresponding prospective payment for each discharge under that DRG. The net income generated by treating patients assigned to a DRGk is given by: (mk)(Rk) - (mk)(FCk), and (mk)(Rk) < (mk)(FCk) represents the total losses resulting from the treatment of patients assigned to a DRG (Rosko, p. 202).

The goal of a hospital to produce a profit as opposed to generating a loss depends on the relationship between the cost of providing care for DRGs on an aggregate basis, and the amount it is prospectively reimbursed for its DRGs on an aggregate basis (Hartzke). The implications of this are that hospitals are motivated to alter the mix of patients within given DRGs so as to minimize the corresponding loss or to maximize the resulting net income (Rosko, p. 203). The facility should keep in mind, however, that it does not create what is called a "DRG creep." This is the deliberate and systematic shift in a hospital's reported case mix to improve reimbursement (Hartzke). The second concern the hospital should consider is that

DRGs do not reflect the severity of illness of a certain patient. A large variation could exist between specific patients in the same DRG due to varying levels of severity of illness.

Linear Programming

The idea of applying a linear program to measure an optimal use of resources has been performed by a variety of industries in the past. Linear, Integer, and Quadratic Programming have been used to solve real industrial, linear, quadratic, and integer programs of respectable size. The use of a model can then save time, money, and the risks associated the experiment if it were actually performed (Hollis, p. 272). Mathematical models can be categorized into two major groups, analytical and simulation models. This project will focus on the use of analytical models, especially linear programming (LP). Linear Programming is a mathematical technique for finding the best uses of an organization's resources. The adjective linear is used to describe whatever relationship exists between two or to describe whatever relationship exists between two or more variables, and programming refers to the use of certain mathematical techniques (Levin, p. 329). A linear program problem has four major parts:

1. The problem must have an objective. In this problem the objective is to maximize the relative weighted products based on DRG classified procedures.

2. There must be alternative courses of action, one of which achieves the objective. The mixture of physicians, time, and numbers of procedures provides several courses of action in this problem.

3. Resources must be in limited supply. A long standing problem in the Army Medical Department (AMEDD) is the shortage of personnel and the funds to adequately operate at maximum capacity.

4. The problem objective, and all variables associated with it, must be expressed in mathematical equalities and inequalities (Levin, p. 329).

There are obvious advantages to using a linear program to formulate the optimum mix, but there are some disadvantages as well. A LP is not always the best method to use when faced with the intricate complexities of staff utilization with all the possible variations of dealing with time off, weekends, leave, etc. (Hollis, p. 273).

The type of linear program used to reach a solution to this problem is the Linear Interactive, and Discrete Optimizer (LINDO). This is a program which is designed to be useful to a wide range of users. The guiding design philosophy has been that if a (potential) user wants to do something simple, then there should not be a large setup cost to learn the necessary features of LINDO. At the other extreme, LINDO has been used to solve real industrial linear, quadratic, and integer programs of respectable size. On mainframe and large personal computers, linear programs, have been used to solve problems with over 1000 rows and several thousand variables (Schrage, p. 1).

Before running such a program it was necessary to examine the structure of the methodology. To be interpretable, a test must be reliable. Since unreliable measurement is measurement overloaded with error, the determinations of relations becomes a difficult and tenuous business (Kerlinger, p. 415). There are three types of validity that can be measured, content, criterion related and construct. For the purposes of this project, the construct validity was addressed. The significant point about construct validity that sets it apart from the other types of validity is its preoccupation with theory, theoretical constructs, and scientific empirical inquiry involving the testing of hypothesized relations (Kerlinger, p. 420). This project will address both questions of reliability and validity. The reliability issue is resolved by following the tenants of constructing a linear program. Once the variables and constraints are identified, the crux of reliability or "are we measuring things right?" is answered. The validity concern is addressed by examining the variables themselves. The inputs or variables of types of physicians, nurses and technicians, plus the ORs and equipment capabilities address those areas over which management has control. Because the management controls these areas, it is possible to assert some influence over the optimal solution. The idea of whether or not "we are measuring the right things" is addressed here also. While mentioning validity and reliability it is also important to mention the right to privacy. Great care was taken to preserve the confidentiality of the patients and physicians used in constructing this model. There is no direct mention of any patient name nor is their specific reference to an individual OBGYN physician by name.

Purpose of the Study

The purpose of this study was to formulate a linear program approach to optimize the DRG reimbursable rate at Winn Army Community Hospital for specific OBGYN DRGs.

The objective or maximization aspect was expressed in mathematical terms with the variables expressed with a coefficient of measure. The variables in this study were the 27 OBGYN DRGs that were seen at Winn ACH. The constraints represented the physical limitations of the available physician time, maximum levels of cases based on overall demand, and minimum levels of cases for CME requirements.

Methods and Procedures

Subjects

This project was conducted in three phases. The phases consisted of data collection, analysis, formulation of an objective function and constraints for the linear program, and finally, analysis of information derived from the linear program. The data consisted of OB-GYN DRGs (codes 354-384) obtained from Patient Administration Biostatistics Activity (PABSA) (Table 2).

Table 2

OBGYN DRG Codes for WACH

DRG Code	Title
354	Uterine procedure for malig age >69
355	Uterine procedure for malig age <70
358	Uterine procedure for non-malig age >69
359	Uterine procedure for non-malig age <70
360	Vagina, cervix and vulva procedures
361	Laparoscopy and incisional tubal inter
362	Endoscopic tubal interruption
363	D & C for malig
364	D & C not for malig
365	Other female system O.R. Procedures
367	Malignancy, Female repro system , age <70
368	Infections, female repro systems
369	Menstrual and other female disorders
370	Cesarean section with CC
371	Cesarean section w/o CC
372	Vaginal delivery with complications
373	Vaginal delivery w/o complications
374	Vaginal delivery with sterilization
376	Postpartum diagnosis with O.R. Procedure
377	Postpartum diagnosis w/o O.R. Procedure
378	Ectopic Pregnancy
379	Threatened abortion
380	Abortion w/o D & C
381	Abortion w D & C
382	False Labor
383	Other antepartum diagnosis with complic
384	Other antepartum diagnosis w/o complic

The information from PASBA contained the number of dispositions, mean length of stays, case mix index, relative weighted products, and relative case mix index of each DRG (Table 3).

Table 3

Descriptive Statistics of 27 OBGYN DRGs

DRG CODE	Mean LOS	CMI	RCMI	# of Disp
354	5	1.5556	1.9184	1
355	5.25	1.0703	1.3199	4
358	9.44	1.5093	1.8612	9
359	5.18	.9410	1.1605	62
360	3.77	.8365	1.0316	13
361	1.98	.7751	.9558	59
362	1.29	.3657	.4510	24
363	2.2	.6366	.7851	10
364	2.21	.5547	.6840	24
365	2.00	1.2070	1.4885	1
367	1.00	.6098	.7509	2
368	4.23	.6101	.7524	13
369	2.45	.5194	.6405	20
370	6.43	1.1235	1.3855	30
371	5.09	.9009	1.1110	187
372	4.42	.8809	1.8063	86
373	3.26	.4739	.5844	782
374	3.37	.6916	.8529	35
376	3.90	.4692	.5786	10
377	2.00	.6218	.7660	4
378	5.13	.8414	1.3076	32
379	2.13	.3244	.4000	67
380	3.25	.4068	.5016	12
381	2.04	.4770	.5882	97
382	1.92	.1479	.1824	13
383	3.38	.3671	.4527	125
384	2.43	.4302	.5306	67

Descriptive statistics were developed from each set of values of the DRGs. In order to determine the resource intensity of each DRG in relation to each other and the other DRGs within the hospital, it was necessary to calculate the case mix index and relative case mix index for each DRG. The case mix index (CMI) is defined as the total relative weighted products (RWP) for a medical treatment facility divided by the total of the biometrics dispositions for which the RWPs were determined. The CMI includes short and long stay outliers. The CMI gives the average RWPs per disposition (Mayer). The relative case mix index (RCMI) is the MTF CMI divided by the FY 85 DOD CMI. This calculation standardizes workload credit such that the average discharge across all of DOD receives a workload credit of 1.00.

For a given MTF, a RCMI of 1.35 would indicate that based on case mix alone, that MTF's disposition should be 35% more resource intense than the DOD average, everything else being equal (Mayer). Table 4 shows the relationship of the RCMI of the DRG codes within the OBGYN group after the DRGs have been standardized to a DOD standard of 1. The resource intensity of the DRGs can be compared to other DRGs in the facility.

TABLE 4

OBGYN CMI/RCMI

OBGYN CMI	.5903
OBGYN RCMI	.8432

This concept was applied one level further to standardize the DRG workload among the OBGYN DRGs within the facility to calculate what will be called DRG Group CMI (DGCMI), and DRG Group RCMI (DGRCMI). The DGCMI was calculated for the set of OBGYN DRGs by dividing the total RWPs by the total number of dispositions for these DRGs. The OBGYN DGRCMI was then calculated by dividing the DRG CMI by the facility CMI. This figure revealed the resource intensity of the OBGYN DRG group relative to the other DRGs in the facility. The DRG group DGCMI and DGRCMI are shown in Table 5.

Table 5

OBGYN DG CMI/RCMI

OBGYN DGCMI	.7001
OBGYN DGRCMI	.8634

Each DRG had a CMI and RCMI calculated for them using the same methodology. The RWP of each DRG was divided by the number of dispositions to calculate the Indexed OBGYN DRG CMI (ICMI). The indexed CMI was divided by the facility CMI to produce the Indexed OBGYN DRG RCMI (IRCMI). The ICMI and IRCMI are shown at Table 6. The relationship of the resource intensity of the 27 OBGYN DRGs vary over the group. The IRCMI, shows this variance. The next set of data came from determining the physician constraints of available time. This was derived from calculating how much time was devoted to inpatient care from the MEPRS data. An analysis of the physician productivity report and interviews with each of the OBGYN physicians revealed a framework of time spent on this area.

TABLE 6

OBGYN ICMI/IRCMI

OBGYN ICMI	.0564
OBGYN IRCMI	.0805

The last set of data gathered in this set came from the TDA and detailed the numbers of physicians involved in the study. Table 7 shows the Table of Distribution and Allowances (TDA) for the actual, on hand OBGYN Clinical staff at WACH.

TABLE 7

TDA for OBYGN Clinical Personnel

OBGYN Surgeons	:	5 Military	0 Civilian
Nurses	:	0 Military	2 Civilian
Prac Nurses	:	0 Military	1 Civilian
Nursing Assts	:	0 Military	2 Civilian
Enlisted Tech	:	5 Military	

Study Design

The linear program (LP) had an objective function that yielded a maximum weight for the Relative Weighted Products as set in the supply allocation calculations. A Relative Weighted Product (RWP) is the disposition from biometrics weighted by the CHAMPUS DRG relative weight. Each disposition from the Services' biometrics system is assigned to a DRG and weighted by the appropriate CHAMPUS weight for that DRG in accordance with the rules for workload credit. The sum of the weighted dispositions for a clinical service, medical treatment facility, major command etc. is the total RWPs for that level of accumulation (Mayer). The variables were formulated with a coefficient reflecting the resource intensity of each DRG as outlined above and its contribution to the MWU formulation. The constraints were drawn from the time limitations of the physicians ,the minimum amount of each type of DRG based on physician preference, and the maximum number of cases that were performed based on total demand. The time issue was determined by analyzing the physician productivity report compiled monthly at the MEDDAC through the Medical Personnel and Expense Report (MEPRS) (Appendix A-M). This report showed the actual hours worked for each physician for every month in FY 88. The 12 months were calculated to provide an average time for each physician. The hours were then totaled to provide an average time the 5 physicians spent on inpatient procedures. This time was used as the best estimate of physician availability for the FY. The end result was used as the right hand side value in the time constraint. Because there were 27 DRGs that involve OBGYN procedures, it was necessary to examine a method of reducing the variables to a number that was easy to work with in the objective function. Upon examination there were 10 DRGs that contributed to over 85% of the total number of dispositions for that year as shown in Table 8.

Based on this, the top 10 producing DRGs were

Table 8

% workload of Top 10 DRGs

DRG	Title	Dispositions
359	uterine procedure for non malig	62
361	lap and tubal inter	59
371	C sect w/o cc	187
372	vag delivery w/ compl	86
373	vag delivery w/o compl	782
374	vag delivery w/ steril	35
379	threatened abortion	67
381	abortion w/ D&C	97
383	other antepartum diag w/ compl	125
384	other antepartum diag w/o compl	67
	Total	1567*

* There were an overall total of 1789 OBGYN procedures done so this represents 87.5% of that workload

treated as independent variables and the remaining 17 were treated as an aggregate variable. This greatly reduced the bulky manipulation of 27 variables into 11 distinct variables with which to work. The derivation of the minimum amounts of procedures that were performed were based on the assumption that a certain amount of these procedures were necessary to maintain clinical proficiency. This data was obtained by asking each of the physicians for input on what they felt was necessary to maintain professional proficiency and competency.

The maximum procedures for the problem came from the assumption that the total demand for any procedure could be reflected in the current workload plus the numbers of non-availability statements that were issued for the same time period. This would show the total population that was seeking care for the year.

Another analysis was performed using time in motion observations and physician interviews to determine an average time spent for each procedure (Appendix N-T). The time factor for several of these variables were the same but the DRGs were different.

The times for each of these DRGs were figured by reviewing the DA 5108. This report contained the start time and the finish time for each procedure by the anesthesiologist and the surgeon. The time for surgeon was chosen and several were used to figure an average time. The most complicated DRG was that of vaginal deliveries. There were three separate DRGs that involved vaginal deliveries. The surgeon's time did not vary widely when the times were broken down into the three stages of labor and analyzed. The times were extracted from the Labor Progress Sheet, FM 617 (Appendix W). Labor is divided into three stages. The first stage of labor encompasses the interval of time from the onset of labor until the cervix has become fully dilated (10 cm). This stage is further subdivided into a latent and an active phase. The latent phase is characterized by slow dilatation of the cervix to approximately 4 cm. The active phase ensues and is characterized by more rapid dilation until 10 cm is achieved. The second stage of labor begins with complete dilatation of the cervix and ends with delivery of the infant. It is frequently characterized by voluntary and involuntary pushing by the patient during uterine contractions, to help deliver the infant. The third stage of labor denotes the interval from the delivery of the infant to the delivery of the placenta (afterbirth) (Niswander, 1987 p. 331). The ranges of vaginal birth time varied extremely from several minutes to several hours if the total time was taken in account. By examining the stages separately however the times of the Second Stage and Third Stage were not as varied. These are also the stages where a physician must be present. These times were examined using these stages and used to calculate an average time (Appendix Q). The actual differences in the DRGs did not affect the later stages and were usually focused on the First Stage or after the Third Stage. There are 11 variables that impact on the problem. The objective function was constructed using these 11 variables as constraints (Table 9).

Table 9

Variables for Problem

X359 =	uterine proc for non malig < 70
X361 =	lap and tubal interruption
X371 =	C section w/o CC
X372 =	vag delivery w/ CC
X373 =	vag delivery w/o CC
X374 =	vag delivery w/ sterilization
X379 =	threatened abortion
X381 =	abortion w/ D&C
X383 =	other antepartum diag w/ cc
X384 =	other antepartum diag w/o cc
X000 =	the other 17 DRGs as an aggregate

In order to show the optimum reimbursable product for these DRGs, it was necessary to involve the RWPs for the DRG group. The coefficients of the variables were the respective RWP for the top 10 DRGs and the average for all the remaining DRGs in variable X000 (Appendix U). Upon completion of this the final objective function for the LP was constructed (Table 10).

Table 10

Objective Function

.9826 X359 + .6894 X361 + .9012 X371 +
.8102 X372 + .4666 X373 + .6730 X374 +
.3214 X379 + .3652 X381 + .3560 X383 +
.3615 X384 + .7392 X000.

The constraints as identified earlier were time and the minimum and maximum procedures. The minimum procedures were based on physician preference. This was determined through an interview with the Chief and one other physician in the OBGYN clinic. They were asked to present the minimum numbers of cases they would like to see performed in their clinic over a years time. The maximum procedures were originally based on determining the total number of demand by adding the numbers of dispositions of the DRGs to the number of non availability statements issued for each DRG. Unfortunately, no records are kept at either the facility level or even the Office of CHAMPUS as to the types of cases by DRG. It became necessary at this point to estimate the total demand by taking the total number of OBGYN non-availability statements which was 560 for FY 88. Based on a total of 1,789 dispositions this represents 31% of the workload that was CHAMPUS'd out. Applying that percentage to each DRG will give an approximation of the total demand (Appendix V).

The completed objective function with the constraints is shown in Table 11.

Table 11

Final Equation for LINDO Program

Maximize .9826 X359 + .6894 X361 + .9012 X371 + .8012 X372 + .4666 X373 + .6730 X374 + .3214 X379 + .3652 X381+ .3560 X383 + .3615 X384 +.7932 X000

Constraints:

Time

.4 X359 + .46 X361 + .81 X371 +.41 X372 + .41 X373+ .41 X374 + 1.03 X379 + .36 X381 + .48 X383 +.48 X384 + .50 X000 <= 575 hours

MAX Procedures	Minimum Procedures
X359 <= 39	X359 >= 20
X361 <= 37	X361 >= 20
X371 <= 23	X371 >= 20
X372 <= 54	X372 >= 50
X373 <= 98	X373 >= 75
X374 <= 22	X374 >= 20
X379 <= 42	X379 >= 20
X381 <= 10	X381 >= 8
X383 <= 79	X383 >= 60
X384 <= 42	X384 >= 30

Results

The first run of the LINDO program produced the following results:

LP OPTIMUM FOUND AT STEP 16

OBJECTIVE FUNCTION VALUE

1) 849.403300

VARIABLE	VALUE	REDUCED COST
X359	39.000000	.000000
X361	20.000000	.000000
X371	20.000000	.000000
X372	54.000000	.000000
X373	75.000000	.000000
X374	22.000000	.000000
X379	20.000000	.000000
X381	8.000000	.000000
X383	60.000000	.000000
X384	30.000000	.000000
X000	812.720000	.000000

ROW	SLACK OR SURPLUS	DUAL PRICES
2)	.000000	1.586400
3)	.000000	.348040
4)	17.000000	.000000
5)	3.000000	.000000
6)	.000000	.150776
7)	23.000000	.000000
8)	.000000	.022576
9)	22.000000	.000000
10)	2.000000	.000000
11)	19.000000	.000000
12)	12.000000	.000000
13)	19.000000	.000000
14)	.000000	-.040344
15)	.000000	-.383784
16)	4.000000	.000000
17)	.000000	-.183824
18)	2.000000	.000000
19)	.000000	-1.312592
20)	.000000	-.205904
21)	.000000	-.405472
22)	.000000	-.399972

NO. ITERATIONS= 16

RANGES IN WHICH THE BASIS IS UNCHANGED:

OBJ COEFFICIENT RANGES

VARIABLE	CURRENT COEF	ALLOWABLE INCREASE	ALLOWABLE DECREASE
X359	.982600	INFINITY	.348040
X361	.689400	.040344	INFINITY
X371	.901200	.383784	INFINITY
X372	.801200	INFINITY	.150776
X373	.466600	.183824	INFINITY
X374	.673000	INFINITY	.022576
X379	.321400	1.312592	INFINITY
X381	.365200	.205904	INFINITY
X383	.356000	.405472	INFINITY
X384	.361500	.399972	INFINITY
X000	.793200	.027532	.043852

RIGHTHAND SIDE RANGES

ROW	CURRENT RHS	ALLOWABLE INCREASE	ALLOWABLE DECREASE
2	575.950000	INFINITY	406.360000
3	39.000000	1015.900000	19.000000
4	37.000000	INFINITY	17.000000
5	23.000000	INFINITY	3.000000
6	54.000000	991.122000	4.000000
7	98.000000	INFINITY	23.000000
8	22.000000	991.122000	2.000000
9	42.000000	INFINITY	22.000000
10	10.000000	INFINITY	2.000000
11	79.000000	INFINITY	19.000000
12	42.000000	INFINITY	12.000000
13	20.000000	19.000000	INFINITY
14	20.000000	17.000000	20.000000
15	20.000000	3.000000	20.000000
16	50.000000	4.000000	INFINITY
17	75.000000	23.000000	75.000000
18	20.000000	2.000000	INFINITY
19	20.000000	22.000000	20.000000
20	8.000000	2.000000	8.000000
21	60.000000	19.000000	60.000000
22	30.000000	12.000000	30.000000

Associated with each variable in any solution is a quantity known as the reduced cost. If the units of the objective function are dollars and the units of the variable are gallons, then the units of the reduced cost are dollars per gallon (Schrage, p. 17). In this case the units of the objective function are in RWPs and the units of the variables are in hours. The units of the reduced cost are then RWPs per hour. Its value is the amount by which the variable profit contribution of the variable must be improved before the variable in question would have a positive value in the optimal solution. Obviously a variable which already appears in the optimal solution will have a zero reduced cost, as in the final solution (Schrage p. 17). Associated with each constraint is a quantity known as the dual price. If the units of the objective function are in RWPs and the units of the constraint in question are in hours, then the units of the dual price are RWPs per hour. Its value is the rate at which the objective function value will improve as the right-hand-side or constant term of the constraint is decreased in a small amount (Schrage p. 17).

Different LP packages may use different sign conventions with regard to the dual price. LINDO uses the convention that a positive dual price means that increasing the right-hand side in question will improve the objective function value, while a negative dual price means that increasing the right-hand-side value will cause the objective function value to deteriorate. A zero dual price means that changing the right-hand-side a small amount will have no effect on the solution value. In general the two interpretations may be summed as follows:

Reduced cost of an (unused) activity: amount by which profits will decrease if one unit of this activity is forced into the solution.

Dual price of a constraint: amount by which profits will decrease if the availability of the resource associated with this constraint is reduced by one unit.

The presence of ***INFINITY*** in the solution means that increasing the profitability of a DRG by any positive amount would have no effect on the optimal amount of the DRGs to produce. This is intuitive because that

DRG is already being produced to its upper limit (Schrage, p. 18).

The interpretation of the solution resulted from examining the different sections that LINDO provided. The objective function value of 849.403300 is the optimal sum of the RWPs that are produced from the variables. Each of the variables were either maximized entirely or minimized in the dual price. Variables X359, X361, X371, X373, X379, X381, X383, and X384 were solved using the minimum values. X372, and X374 were solved using the maximum values. Because the variables are either the minimum or maximum amounts that appeared in the equation means the reduced cost is zero. This meant that the optimal amount of the RWP was reached and can not be improved to reach a positive value in the solution. Further examinations of the dual prices revealed that in certain DRGs the total RWP will decrease if that DRG is reduced by one procedure. The time constraint showed that if it were reduced by one hour the total RWP produced per hour would decrease by 1.586400. The remaining DRGs showed that an increase in the variable by one procedure would decrease the objective function value (negative dual price), or increase the objective function value (positive dual price).

The section on Objective Coefficient Ranges showed that if the RWPs for each DRG were changed in the future by HFCA, the optimal solution would not change if they remained within the ranges shown.

The right hand side ranges revealed the amounts that the procedures could be decreased or increased without an effect on the optimal solution. The presence of INFINITY meant that the DRG could be increased or decreased by any amount and not have an effect on the solution, because the DRG was already produced at its upper or lower limit.

Taking one DRG upon examination showed the following information: DRG 373 (Vaginal deliveries without complications) had a minimum value of 75 and a maximum value of 98; the RWP was .4666; and the LINDO solution presented it with its minimum value of 75 and no reduced cost. This meant the value selected at 75 already appeared in the constraints and the optimal solution was reached. The DRG had a slack of 23 which is the difference between the minimum and maximum value. The RWP could change from the .4666 to anywhere between .183824 and infinity, and not change the final solution. The right hand side value could increase to infinity and decrease by 23 to 75 and not change the value. This is important when looking at the DRG to see if workload could be increased or decreased.

Conclusions and Recommendations

The expected utility of this type of program was to obtain a prescriptive analysis of the workload under the DRG system. In this problem only one service, the OBGYN clinic and selected DRGs, were examined. The concept once established could be applied to the hospital as an aggregate to analyze total workload. The DRGs can be taken one by one, and the reduced costs and dual prices guide the administrator in deciding what DRGs contribute to the solution in what amounts. In this problem the 10 highest produced DRGs were identified and the solutions pointed to each DRG and the optimal amounts that should be performed by the staff within a one month period in order to get the highest RWP. The extended premise is that this will lead to a higher reimbursement under the DRG system. The one flaw with this problem is that it does not identify the cost associated with each DRG. Therefore, the maximum reimbursement for a procedure could be less than the total cost. To get this problem to really answer that question, a contribution to profit must be determined for each DRG and the problem will take that as part of the solution. The current financial system in the military is not set up to give that information in a readily retrievable form. The coefficients in the objective function can be changed to reflect Case Mix Indices or any other measurable form the administrator chooses. The constraints can be changed to reflect shorter or longer procedure times as new technology comes on board and the minimum and maximum numbers can be changed to reflect changes in staffing. The ultimate goal of this type of program is to establish a guide, not a firm set of rules which are set in concrete. The intent is to assist with the transition to DRG management by providing a roadmap for the command. This map will help to decide what DRGs are the most profitable to the institution by its contribution to the RWP. Above all, quality patient care and not the dollar should be the ruling law. If such a program is used strictly to determine what types of patients are treated in the facility and which are CHAMPUS'd out then a great ethical blunder has been made. Statistics and computer programs should be used to assist and not determine what the patient treatment course should be. That is the one rule that should never be lost or misunderstood in any way.

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Appendix A MEPRS Information on Doctor's Inpatient Hours

Oct 87	ACAA/GYN	ACAB/OB	
Physician A	72.75	72.75	
Physician B	1.4	11.2	
Physician C	22.8	57	
Physician D	16	128	
Physician E	42.8	64.2	
Total	155.75	333.15	488.9
Avg	31.15	66.63	48.89

Appendix B MEPRS Information on Doctor's Inpatient Hours

Nov 87	ACAA/GYN	ACAB/OB	
Physician A	69.25	69.25	
Physician B	11.6	92.8	
Physician C	25.7	64.25	
Physician D	11	88	
Physician E	46.6	69.9	
Total	164.15	384.2	548.35
Avg	32.83	76.84	54.835

Appendix C MEPRS Information on Doctor's Inpatient Hours

Dec 87	ACAA/GYN	ACAB/OB	
Physician A	64.5	64.5	
Physician B	168	103.2	
Physician C	12.9	51.25	
Physician D	20.5	113.6	
Physician E	14.2	72.3	
Total	280.1	404.85	684.95
Avg	56.02	80.97	68.495

Appendix D MEPRS Information on Doctor's Inpatient Hours

Jan 88	ACAA/GYN	ACAB/OB	
Physician A	60.5	60.5	
Physician B	140	41	
Physician C	7.8	62.4	
Physician D	21	52.5	
Physician E	13.8	110.4	
Total	243.1	326.8	569.9
Avg	48.62	65.36	56.99

Appendix E MEPRS Information on Doctor's Inpatient Hours

Feb 88	ACAA/GYN	ACAB/OB	
Physician A	55.25	55.25	
Physician B	189	56.5	
Physician C	5.6	44.8	
Physician D	15.2	38	
Physician E	14.5	116	
Total	279.55	310.55	590.1
Avg	55.91	62.11	59.01

Appendix F MEPRS Information on Doctor's Inpatient Hours

Mar 88	ACAA/GYN	ACAB/OB	
Physician A	32.75	32.75	
Physician B	168	47.6	
Physician C	12.4	99.2	
Physician D	8.4	67.2	
Physician E	18	27	
Total	239.55	273.75	513.3
Avg	47.91	54.75	51.33

Appendix G MEPRS Information on Doctor's Inpatient Hours

Apr 88	ACAA/GYN	ACAB/OB	
Physician A	71.5	71.5	
Physician B	144	22.3	
Physician C	8.9	71.2	
Physician D	15.2	121.6	
Physician E	4.4	6.6	
Total	244	293.2	537.2
Avg	48.8	58.64	53.72

Appendix H MEPRS Information on Doctor's Inpatient Hours

May 88	ACAA/GYN	ACAB/OB	
Physician A	58	58	
Physician B	148	18.3	
Physician C	7.4	59.2	
Physician D	12.9	103.2	
Physician E	52.4	78.6	
Total	278.7	317.3	596
Avg	55.74	63.46	59.6

Appendix I MEPRS Information on Doctor's Inpatient Hours

Jun 88	ACAA/GYN	ACAB/OB	
Physician A	44.5	44.5	
Physician B	200	10.2	
Physician C	9.2	73.6	
Physician D	15.4	123.2	
Physician E	56	84	
Total	325.1	335.5	660.6
Avg	65.02	67.1	66.06

Appendix J MEPRS Information on Doctor's Inpatient Hours

Jul 88	ACAA/GYN	ACAB/OB	
Physician A	52.75	52.75	
Physician B	212	12.4	
Physician C	12.4	99.2	
Physician D	11.2	89.6	
Physician E	44.8	67.2	
Total	333.15	321.15	654.3
Avg	66.63	64.23	65.43

Appendix K MEPRS Information on Doctor's Inpatient Hours

Aug 88	ACAA/GYN	ACAB/OB	
Physician A	72.5	72.5	
Physician B	129	12.3	
Physician C	8.8	70.4	
Physician D	8.8	70.4	
Physician E	53.2	79.8	
Total	272.3	305.4	577.7
Avg	54.46	61.08	57.77

Appendix L MEPRS Information on Doctor's Inpatient Hours

Sep 88	ACAA/GYN	ACAB/OB	
Physician A	64.5	64.5	
Physician B	92	13.7	
Physician C	4.8	38.4	
Physician D	8.8	70.4	
Physician E	53.2	79.8	
Total	223.3	266.8	490.1
Avg	44.66	53.36	49.01

Appendix M MEPRS Consolidated Information

Month	Total Hours	
Oct	488.9	
Nov	548.35	
Dec	684.95	
Jan	569.9	
Feb	590.1	
Mar	513.3	
Apr	537.2	
May	596	
Jun	660.6	
Jul	654.3	
Aug	577.7	
Sep	490.1	
Total	6911.4	
Avg	575.95	average hours per month per 5 Physicians in inpatient care

Appendix N

Uterine Procedures for Non–Malig <70 (DRG 359)

Start	Finish	Elapsed Time
13:45	14:20	00:35
09:35	09:50	00:15
11:13	11:40	00:27
09:49	10:00	00:11
10:57	11:10	00:13
11:58	12:20	00:22
08:10	08:40	00:30
09:56	10:10	00:14
09:30	10:05	00:35
08:05	08:47	00:42
07:50	08:05	00:15
08:40	08:46	00:06
10:21	11:18	00:57
Average time for DRG 359		**00:24**

Appendix O

Laparoscopy and Tubal Interuption (DRG 361)

	Start	Finish	Elapsed Time
	10:21	11:18	00:57
	07:56	08:20	00:24
	09:35	09:50	00:15
	09:45	10:04	00:19
	10:55	11:08	00:13
	11:55	12:23	00:28
	08:00	08:50	00:50
	09:50	10:06	00:16
	09:27	10:03	00:36
	08:05	08:47	00:42
	07:58	08:10	00:12
	08:40	08:46	00:06
	10:32	11:20	00:48
Average time for DRG 361			**00:28**

Appendix P

C SECTION (DRG 371)

Start	Finish	Elapsed Time
22:49	23:45	00:56
09:09	10:05	00:56
16:06	16:50	00:44
12:20	13:10	00:50
18:03	18:48	00:45
07:06	07:40	00:34
09:43	10:39	00:56
14:26	15:05	00:39
07:04	07:59	00:55
08:09	09:00	00:51
18:02	18:50	00:48
03:46	04:51	01:05
01:01	01:48	00:47

Average time for C Section 00:49

Appendix Q

Vaginal Delivery with Complications (DRG 372)
Vaginal Delivery without Complications (DRG 373)
Vaginal Delivery with Sterlization (DRG 374)

	Stage II	Stage III	Elapsed Time
	00:05	00:10	00:15
	00:20	00:05	00:25
	00:08	00:09	00:17
	00:04	00:03	00:07
	00:34	00:05	00:39
	00:02	00:10	00:12
	00:11	00:09	00:20
	00:40	00:06	00:46
	00:31	00:04	00:35
	00:13	00:04	00:17
	00:16	00:08	00:24
	00:57	00:09	01:06
	00:05	00:02	00:07
Average time for DRG 361			**00:25**

Appendix R

Threatened Abortion (DRG 379)

	Start	Finish	Elapsed Time
	18:55	19:10	00:15
	08:23	09:49	01:26
	14:56	15:16	00:20
	07:05	07:45	00:40
	15:35	16:45	01:10
	07:50	08:55	01:05
	03:46	04:51	01:05
	08:40	10:03	01:23
	10:21	11:45	01:24
	07:05	08:10	01:05
	08:09	09:02	00:53
	09:23	11:15	01:52
	22:27	23:25	00:58
Average time for DRG 379			**01:02**

Appendix S

Abortion with D+C (DRG 381)

	Start	Finish	Elapsed Time
	13:30	13:55	00:25
	14:20	14:25	00:05
	00:50	01:20	00:30
	11:20	11:29	00:09
	18:55	19:10	00:15
	10:25	11:10	00:45
	18:30	18:40	00:10
	22:35	22:45	00:10
	16:20	16:55	00:35
	11:48	12:20	00:32
	10:45	10:57	00:12
	18:35	19:05	00:30
	11:50	12:30	00:40
Average time for DRG 381			**00:22**

Appendix T

Other Antepartum Diagnosis with Complications (DRG 383)
Other Antepartum Diagnosis without Complications (DRG 384)

	Start	Finish	Elapsed Time
	07:56	08:20	00:24
	11:04	11:25	00:21
	07:49	08:00	00:11
	08:40	09:00	00:20
	06:53	07:35	00:42
	08:16	08:38	00:22
	08:10	09:40	01:30
	13:44	14:18	00:34
	09:39	09:54	00:15
	07:30	07:50	00:20
	10:45	10:57	00:12
	06:54	07:25	00:31
	11:50	12:30	00:40
Average time for DRG 383,384			**00:29**

Appendix U

Relative Weighted Products for OBGYN DRGs

RWPS for DRGs

	DRG	RWP
10 DRGs	359	0.9826
used in	361	0.6894
Obj Func	371	0.9012
	372	0.8102
	373	0.4666
	374	0.6730
	379	0.3214
	381	0.3652
	383	0.3560
	384	0.3615
Remaining	354	1.5556
DRGs	355	1.0703
	358	1.3064
	360	0.6131
	362	0.3483
	363	0.6366
	364	0.4863
	365	1.2070
	367	0.6089
	368	0.6357
	369	0.4241
	370	1.0878
	376	0.4692
	377	0.6218
	378	0.8096
	380	0.3211
	382	0.3652
Avg RWP		0.7392

Appendix V Min and Max Procedures

DRG	DRG TITLE	Max #	Min #
359	Uterine Procedures for Non Malignancy <70	39	20
361	Lap and Tubal Interuption	37	20
371	C Section without Complications	23	20
372	Vaginal Delivery with Complications	54	50
373	Vaginal Delivery without Complications	98	75
374	Vaginal Delivery with Sterlization	22	20
379	Threatened Abortion	42	20
381	Abortion with D&C	10	8
383	Other Antepartum Diagnosis with Complication	79	60
384	Other Antepartum Diagnosis without Complication	42	30

MEDICAL RECORD | **LABOR**

(OVERPRINT)

GRAVIDA	PARA	AB	NO. LIVING	AGE	LENGTH OF PREGNANCY	EST. DATE CONFINEMENT	TOTAL WEIGHT GAIN

ONSET OF LABOR	MEMBRANES ON ADMISSION	BLEEDING ON ADMISSION	RH TYPE	BLOOD TYPE	SEROLOGY

EXAMINATIONS DURING LABOR (R—Rectal, V—Vaginal)

DATE	HOUR	R OR V	POSITION	MEMB.	F. H. T.	CERVIX		STATION OF PRESENTING PART	BP	MEDICATIONS AND REMARKS	INITIALS
						EFFACE	DILAT				

REMARKS

PATIENT'S IDENTIFICATION *(Name—last, first, middle; grade; rank; rate; hospital or medical facility)*	IDENTIFICATION NO.	ORGANIZATION	REGISTER NO.	WARD NO.

Labor
Standard Form 534 (Rev. 12–74)
Prescribed by GSA/IMCR
FPMR 101–11.806–8
534–106

FST MEDDAC FM 617 (L&D) 1 JUL 88

FIRST STAGE

ONSET	PROGRESS	MEDICATION	DURATION

SECOND STAGE

ONSET	ANESTHESIA	TIME & DATE OF DELIVERY	MEDICATION

SKIN PREPARATION	POSITION	EPISIOTOMY	LACERATION	DURATION

METHOD OF DELIVERY WITH INDICATIONS

THIRD STAGE

ONSET	METHOD AND TIME OF DELIVERY	MEDICATION

APPEARANCE OF PLACENTA & CORD	DURATION

LABOR

COMPLICATIONS	EST. BLOOD LOSS	DURATION

INFANT

PERINATAL COURSE		APGAR RATING								
SEX										
WT.			1'	5'		1'	5'		1'	5'
LENGTH		HEART RATE			TONE			COLOR		
		RESP.			REFLEX			TOTAL		

REMARKS

SIGNATURE OF PHYSICIAN	DATE

POST PARTUM COURSE

Dates	pp#	Fundus	Lochia	Episiotomy	Hemorrhoid	Breast	Remarks
	1.						
	2.						
	3.						
	4.						

Discharge Notes

DX

Follow Up

Meds

PP Course

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